

THE PRACTITIONER'S HANDBOOK
OF
DISEASES OF THE EAR
AND
NASO-PHARYNX

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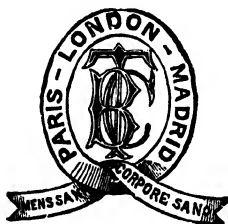
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P R E F A C E

THE first edition of this manual appeared in the year 1878. At that time the only works on the ear of any importance in the English language were those of Wilde in Ireland, Toynbee and Hinton in England, the translation of Politzer's Treatise by Patterson Cassells of Glasgow, and the treatises of Roosa and Turnbull in America. The mantle of Toynbee fell on worthy shoulders in the person of James Hinton, who edited the classical work of the former on 'Diseases of the Ear,' and wrote the volume on 'Questions in Aural Surgery,' having first produced his incomparable and original Atlas, which, as an artistic and faithful representation of the diseased conditions it was desired to portray, has never been excelled. This was the period of the infancy of modern aural surgery.

In 1879, we published our Atlas of 'Diseases of the Membrana Tympani,' which was entirely disposed of within a few years. This was the first and last attempt in this country to produce such an atlas by lithography. The cost of production independently of the difficulty of obtaining faithful delineation is deterrent.

Since that time the science of otology has grown apace. The names of the workers to whom we are most indebted for this advance are too familiar to require recapitu-

lation. Many of the foremost are referred to throughout these pages. It will not, however, be thought invidious to name a few: Trötsch, Politzer, Mayer, Gruber, Weber, Liel, Schwartze, Lucae, Bezold, Zaufal, Guye, Delstanche, Löwenberg, Hartmann, Ménière on the Continent; Moos, Roosa, and Burnett in America; while McEwen of Glasgow stands out as the one before all others in this country who has given to otology, in its relation to brain surgery, its greatest impetus—an impetus which that able pioneer, Charles Ballance, has not been slow to avail himself of.

Unequivocally the two great advances in modern otology are, first, the recognition of, and the surgical means of dealing with, those morbid states of the middle ear that threaten life by the extension of mischief to the brain and its covering; and, secondly, the influence exerted by abnormal nasal and naso-pharyngeal states in leading up to affections of the ear, and the surgical treatment of these conditions. While we appreciate to the fullest the incalculable benefits that have resulted from such otological gains, it is well to remember that enthusiasm sometimes leads to an excess of surgical zeal, and that operative ardour, even when backed by the most dexterous skill, is not without its dangers. We have seen operative procedures practised and advocated which more mature experience has proved to be futile. Possibly such drawbacks are inseparable from material advance, or before we reach the solid ground of assured indications for interference. It is well, in surgery as in politics, to have at times the critical check of an enlightened and liberal 'opposition.'

In this edition we have had the co-operation of special workers whose names are associated with the particular portions they have written. They are responsible for those portions only. Professor Birmingham's work on the anatomy

and the applied anatomy of the ear is well known; his colleague, Dr. Dwyer Joyce, whose interesting demonstration at the International Congress in 1899 will be remembered by those who were present, has kindly assisted him in writing this part of the manual. Mr. W. R. H. Stewart, who conjointly with us wrote the last two editions of this work, undertook the chapter on the middle ear. Dr. William Milligan has contributed that on complications of chronic suppurative middle-ear diseases (including diseased conditions of the mastoid and intracranial complications). Otologists generally will recognise his special qualifications to carry out such a task. Mr. Herbert Tilley, who has devoted so much attention to affections of the nose and its accessory cavities, has written the chapter devoted to such states as affect the organ of hearing. Dr. Dudley Buxton has kindly added a necessarily condensed chapter on the administration of anæsthetics in nasal and aural surgery. For the rest of the book we are personally responsible, and can only advance the plea of thirty-four years' constant work in otology for assuming this responsibility.

The work is not a treatise for specialists; it is simply what its title indicates—a 'Practitioner's Handbook,' which, we trust, will also be found a useful aid to the student in pursuing his studies in this special department of surgery.

H. MACNAUGHTON-JONES.

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DISEASES OF THE EAR

CHAPTER I

INTRODUCTORY

A SHORT PRACTICAL SURVEY

By H. MACNAUGHTON-JONES

MANY years have elapsed since Wilde of Dublin first drew attention to the general vagueness which existed on the entire subject of ear disease. Only within the last two decades have practitioners generally awakened to the importance of the special study of otology and a clearer insight into the causation, methods of diagnosis, and the treatment of aural affections. The cause of this is not far to seek. Little or no instruction was given in this 'special' branch, and students were satisfied with the most superficial knowledge, or neglected the study of otology altogether. This state of things has now been rectified in most schools of medicine, and it can no longer be said that ample opportunity for the study of aural affections is not provided in the various schools and hospitals.

In the first edition of this work (1879) we strongly commented on this want. In 1881 the Committee of the Otological Section of the British Medical Association reported in forcible terms of the same neglect.*

There is even still a belief in the public mind that there is something mysterious connected with the treatment of

* The first section of otology was instituted at our instance at the Annual Meeting at Cork in 1879.

morbid states of the auditory apparatus, and this fear is expressed in the familiar injunctions given to sufferers 'not to tamper,' 'to avoid meddling,' and 'to let well alone.' The excuse for all this empiricism has long since been removed. The time has arrived when aural therapeutics are completely freed from the atmosphere of charlatanism which pervaded the treatment of diseases of the middle and internal ear, and the care of this most important organ is as intelligently and rationally carried out as that of the eye, the uterus, the male urethra, or the rectum.

The certainty of diagnosis is as perfect, both from positive signs and symptoms and from negative evidences, in the case of aural affections as in morbid states of other organs in the body. A glance at the method by which an exhaustive examination of the ear is conducted and a final verdict given must satisfy anyone on this point. We know of no organs, save the eye and skin, in which we can arrive at more certain and satisfactory conclusions as to the cause of aberration or loss of function than in the case of the ear. He must be a rare diagnostician who would not acknowledge that in the case of the other organs of sense, or of the internal viscera, conditions are frequently met with which baffle his knowledge and contradict his experiences. The oculist and dermatologist have manifest advantages in the completeness of their survey of the diseased states they are called on to treat, and their powers of observation and comparison are accentuated by this facility and education. Even in the instance of the eye and the skin, intricate questions of pathology involve the diagnosis, baffle the localizing power of the examiner, and more or less influence his judgment on matters of therapeutical import. It is no exaggeration to say that the vast proportion of curable or remediable affections of the ear are easily diagnosed, and require no extraordinary skill in their treatment.

These are just the conditions which come within the daily observation of the practitioner. The analysis of any statistical records, hospital or private, would establish the truth of this statement.

Nor are the necessary appliances for aural diagnosis in

the greater number of ear affections met with in daily practice either numerous or costly. A watch, a few aural and nasal specula, a piece of rubber tubing, a laryngeal mirror with a good light, some tuning-forks, a syringe, an aural cotton-wool carrier, a tongue-depressor, and Politzer's inflator, are the essential tools which enable us, in a large proportion of cases, to tell the patient truthfully what are the chances of successful interference.

Thorough acquaintance with the use of three appliances is essential. They are diagnostic. These are the speculum, auscultation-tube (known familiarly as the otoscope), and tuning-fork. And when the physician, both for purposes of diagnosis and treatment, has to apply remedies to the Eustachian tube and middle ear, he should acquire the method of passing the Eustachian catheter with facility and gentleness. With speculum, mirror, and finger he must know how to explore the nose and naso-pharynx; the number of naso-pharyngeal cases in which we find deafness an accompanying trouble necessitating this knowledge.

The nasal speculum, the laryngoscopic or rhinoscopic mirror, and a tongue-depressor are not difficult instruments to master the use of. The manipulative experience and dexterity necessary in the application of local remedies to the external and middle ear are easily acquired by the intelligent practitioner, and are not a whit more difficult to attain than the acquisition of the corresponding dexterity and gentleness of touch which should be exercised in various other surgical procedures, as, for example, the manipulation and treatment of the sensitive urethra. This experience has certainly to embrace the ability for careful and accurate determination of the condition, whether normal or abnormal, of the external ear passage, and the nature of its contents; the ready recognition of the appearance and slight anatomical deviations from the typically normal shape, colour, position of the membrane, and those anatomical peculiarities which are found in a certain proportion of ears in which the hearing-power is perfect. On the other hand, there must be a familiarity with the alterations presented in the shape and position of the drumhead when it has been subject to attacks

of otitis, acute or chronic, or in those cases in which there have been sclerotic changes in the middle ear, with the conditions which induce rigidity of the ossicles and their articulations. With these changes come corresponding alterations in the tone and degree of tension of the intrinsic muscles and accumulations in the tympanic cavity, all of which departures favour the approach and induce the occurrence of lesions of the internal ear and its delicate nervous apparatus.

The skill of the aurist mainly consists in his power of comparatively analyzing and differentiating these associated morbid conditions, and in assigning relatively to each its proportionate part in the production of the symptoms for which he is consulted. We have to decide how far the removal of those abnormal states, which we know to be remediable by operative or therapeutical measures, will enable us to improve our patient's hearing, or—just as important a result—to preserve it. In a certain proportion of cases we know that the chances of improvement are against us, while in others we feel that no good whatever can be done. Frank admission of our position with regard to both these classes of sufferers would save aural surgery from much of the suspicion of quackery which at present is pretty openly hinted at in regard to its therapeutical remedies and applications. We insist that the broad principles of treatment are as safely carried out in the case of morbid conditions of the ear as in those of other organs; that the most essential therapeutical principles, no matter how secured, are *cleanliness* (asepsis in the strictest sense of the word), free *ventilation* of the aural passages, attention to the *state of the naso-pharyngeal mucous membrane*, due regard to the intimate dependence of the normal auditory conditions on a healthful *state of the blood and the arterial and nervous supplies*.

In practice it will be found that very many of the aural affections for which we are consulted, both those of an inflammatory character and those in which there is deterioration of function, have essentially preventable causes, or causes over which the controlling influences within the reach of every physician and surgeon can be exerted so as either to prevent or minimize their pernicious effects.

The *external ear* furnishes a large proportion of the diseases we are called on to treat, and (to take a low estimate) in some 40 per cent. of such patients cerumen (and its associated and attendant evils) is the primary cause of the trouble, or produces the symptoms for which we are consulted; and of the remaining affections of the external ear, inflammation of the meatus, of various degrees of intensity and in different stages, is the condition we have most frequently to combat and limit.

Chronic catarrhal and sclerotic states of the *middle ear* furnish the next largest number of patients, associated with which we frequently find similar morbid conditions of the Eustachian tubes. The practitioner has thus commonly to deal with two causes of deafness—in the external ear accumulations of cerumen, with epidermis and other degenerating débris; in the middle ear, collapse, obstruction, stenosis, or closure of the Eustachian tube.

Next we have the not infrequent, and, relatively, from their sequelæ, the most serious of all forms of aural disease, namely, the various suppurative conditions, acute and chronic, occurring in the middle ear, and passing from it into the mastoid cells or involving the meninges, the cerebellum, or the cerebrum—acute and chronic suppurative otitis media, with mastoid abscess, cerebellar abscess, or invasions of the temporo-sphenoidal lobe. Other associations or consequences of such inflammations are granulations filling or sprouting from the tympanic cavity, so-called vascular and other polypi, with the occurrence of cholesteatomata in the tympanum, the mastoid antrum and cells.

The proportion of affections of the *internal ear* to those of the other parts of the auditory apparatus appears, judging from statistical records, to be relatively small. Yet this is a most misleading inference to draw from any such classification of ear diseases. It is, however, from the scanty clinical and pathological data which we commonly have at our command, often impossible to isolate the internal ear affection from primary or associated middle-ear disease. Such an accurate differentiation cannot always be made between true paralytic states and localized nerve lesions, or limited effusions

of blood or serum, and functional disturbances and paresis from organic changes in the nerve elements. This is the weak side in otological science. It is an easy task to assign to the division of internal ear disease a well-marked case of nervine deafness, labyrinthine vertigo, the combination of objective signs and subjective symptoms, which we group together under the name of Ménière's disease, of those numerous cases in which, from disease or accident, we can have no doubt that permanent lesions exist, traumatic in origin, or the consequence of apoplectic, acute inflammatory, or degenerative changes in labyrinth or cochlea.

It is different in those cases in which there have been serious lesions of the middle ear, such as suppurative catarrh with perforation of the drumhead, old sclerotic changes in the mucus of the tympanic cavity, ossicular ankyloses of the auditory ossicles, or traumatic lesions. Such are commonly attended by varying degrees of internal ear mischief. This involvement of the osseous labyrinth or the auditory nerve may depend not so much on the attendant middle-ear disease as on some systemic condition or morbid change in other organs. In advanced life it may be due to general decay. To determine the question how far the auditory nerve is implicated through some local or extra-auditory causes may be difficult or impossible, but at least it is obviously our duty to make the attempt.

Over these internal ear lesions experience proves we have little power. If due to such constitutional states as general plethora, syphilis, gout, tubercle, and such organic conditions as cardiac disease, albuminuria, or diabetes, we may do much by general and specific treatment to modify or ameliorate—we rarely cure—so that their presence does not affect the question of local treatment. It is rather one of diagnosis and prognosis.

CHAPTER II

THE ANATOMY OF THE EAR

BY AMBROSE BIRMINGHAM AND ROBERT DWYER JOYCE

IN the following account of the anatomy of the ear the organ is considered from the point of view of the general practitioner, and accordingly only such facts have been included as are necessary to a correct understanding of its mechanism, the disturbance of its functions resulting from disease, and the chief operations performed on the part. At the end of the systematic account will be found a short section on the applied anatomy of the ear.

The **organ of hearing** is divided naturally (Fig. 3) into three parts, namely :

1. **The External Ear**.—This includes the portions of the organ visible from the exterior, namely, the pinna and the external auditory meatus. It acts to a slight extent as a sound collector.

2. **The Middle Ear or Tympanum**—a cavity which lies internal to the membrana tympani, and contains the three small ear-bones. With it are connected the Eustachian tube and the mastoid antrum, the former opening on its anterior, the latter on its posterior, wall. The middle ear may be looked upon as the sound transmitter.

3. **The Internal Ear or Labyrinth** (Fig. 8) consists of a tortuous bony passage, containing the complicated epithelial mechanism in which the auditory nerve fibres terminate. It lies buried in the substance of the petrous portion of the temporal bone to the inner side of the tympanic cavity, and constitutes the perceptive portion of the organ of hearing—the sound perceiver. At least one division of the labyrinth,

namely, the semicircular canals, has to do with equilibration rather than hearing.

The External Ear.

As just pointed out, this division of the organ consists of the pinna and the external auditory meatus, the latter being practically a continuation inwards of the deepest part of the pinna.

1. **The Pinna.**—In general shape the pinna or auricle may be said to resemble a shallow cone (Fig. 2), with its apex at the beginning of the external auditory meatus, and its anterior

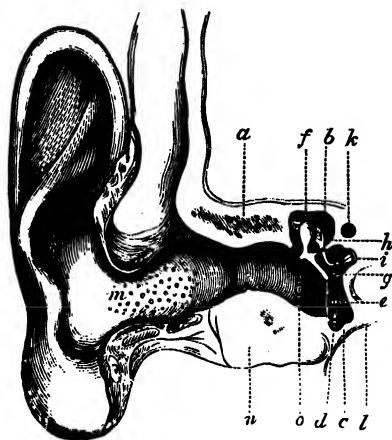


FIG. 1.—VERTICAL SECTION OF EXTERNAL MEATUS, MEMBRANA TYMPANI, AND TYMPANIC CAVITY.

- a*, Cellular spaces in the superior wall of the meatus connected with the middle ear; *b*, roof of the tympanic cavity; *c*, inferior wall; *d*, tympanic cavity; *e*, membrana tympani; *f*, head of the malleus; *g*, handle of the malleus; *h*, incus; *i*, stapes; *k*, Fallopian canal; *l*, fossa jugularis; *m*, apertures of glands in the external meatus; *n*, part of mastoid process. (Right ear.) (After Politzer.)

wall partly cut away. It is made up of a shell of elastic cartilage—absent in the lobule—covered by a layer of thin skin, which is very closely adherent on its outer surface, but less so on the inner, so that the integument can here be moved to some extent on the cartilage. The pinna presents a number of ridges and depressions, to which the following names are given, as shown in Fig. 2.

The slightly-rolled margin of the pinna is the *helix*, the depression just within, and bounded by this is the *fossa of the helix*. The *antihelix* is a ridge, divided Y-like above, lying inside the fossa of the helix, whilst the depression between its two limbs is the *fossa of the antihelix*. Within the antihelix is a large depression, the *concha*, at the lower margin of which are seen the *tragus* in front, projecting backwards over the external auditory meatus, and the *antitragus* behind, opposite the tragus. Finally, the lower end

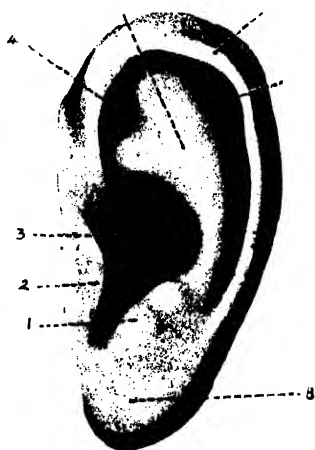


FIG. 2.—THE PINNA OR AURICLE.

- 1, Antitragus; 2, tragus; 3, concha; 4, fossa of antihelix (*Fossa triangularis*); 5, antihelix; 6, helix; 7, fossa of helix (*Fossa scaphoidea*); 8, lobule.

of the pinna is known as the *lobule*; it contains no cartilage, and is formed of fatty connective tissue covered by skin.

Connected with the pinna are certain intrinsic and extrinsic muscles of no practical importance.

The pinna derives its nerve-supply from the auriculo-temporal, great auricular, and small occipital nerves, the former coming from the fifth nerve, the two latter from the cervical plexus. Its arteries are the superficial temporal and posterior auricular.

2. The **External Auditory Meatus** (Figs. 1 and 3) extends from the bottom of the concha to the membrana

tympani. Its general direction is inwards and somewhat forwards, but it is curved in such a manner that both its floor and anterior wall are slightly convex. These two walls, owing to the obliquity of the tympanic membrane, are also longer than the other sides of the canal.

The meatus, measured from the bottom of the concha, is about 1 inch (25 mm.) in length; but if measured from the outer surface of the tragus (a more simple measurement in practice), the length is increased to $1\frac{1}{2}$ inches (37 mm.).

The meatus proper (excluding the concha) is divided into an inner osseous portion a little over $\frac{1}{2}$ inch in length

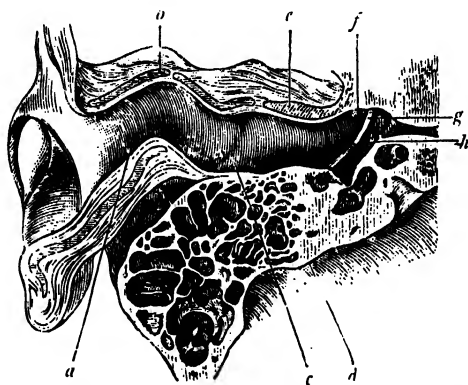


FIG. 3.—HORIZONTAL SECTION OF THE EXTERNAL MEATUS.

a, Concha; *b*, tragus; *c*, place of attachment of the cartilaginous portion; *d*, mastoid process; *e*, anterior wall of the meatus; *f*, recessus meatus audit. extern.; *g*, membrana tympani; *h*, tympanic cavity. (After Politzer.)

(15 mm.), and a shorter outer or cartilaginous portion, which is formed by a prolongation of the cartilage of the pinna.

In general the meatus is nearly $\frac{1}{3}$ inch (8.5 mm.) in diameter, but its calibre is not uniform throughout, for it presents two slight constrictions, one situated in the cartilaginous portion, near its junction with the bone; the other at the inner end of the meatus, a few millimetres from the membrane. In this latter position the meatus is narrowest.

The cartilage of the meatus is deficient above and behind; there are also two nearly vertical gaps (the fissures of

Santorini) in its anterior part, which afford a ready passage for pus from a parotid abscess into the meatus. Where the cartilage is deficient, the wall is completed by fibrous tissue.

Sometimes, as mentioned above, the depth of the concha is included in giving the length of the meatus, and the meatus is then described as being divisible into three parts—an outer or conchal part, extending from the surface of the tragus to the bottom of the concha; a middle or cartilaginous portion, extending from the bottom of the concha to the beginning of the third or osseous portion. These three divisions are well seen on horizontal section, when the meatus presents an S-shaped curvature (Fig. 3); the first or conchal portion runs inwards, forwards, and slightly upwards; the second or cartilaginous part, passing off from the preceding at an angle, runs horizontally inwards and slightly backward; whilst the third or osseous part runs inwards and forwards like the first part, but also distinctly downwards, particularly near the membrana.

By drawing the pinna backwards and upwards the angles of the meatus are opened out, and the passage is rendered nearly straight.

The condyle of the lower jaw is in close relation with the anterior wall of the cartilaginous portion (slightly overlapping the bony part also), and presses upon it, so that when the condyle glides on to the eminentia articularis, in opening the mouth, the meatus becomes wider. Below, the meatus is in contact with the parotid gland in its whole length, whilst behind and above the offshoots from the mastoid cells frequently reach to within 1 or 2 mm. of it (Figs. 1 and 3).

A layer of skin, which grows very thin and delicate in the deeper parts, lines the whole meatus and also covers the outer surface of the membrana tympani. In it large modified sweat glands—the *ceruminous glands* (Fig. 1), which secrete the ear-wax—are found embedded over the cartilaginous portion of the canal; they also extend for a little way into the osseous part above and behind. In the outer part of the meatus, particularly at the back of the tragus, are found a number of stiff hairs, which to some extent prevent the entrance of dust and insects.

3. The **membrana tympani** (Fig. 4) is an oval membranous sheet, about $\frac{1}{8}$ inch (8 or 9 mm.) in diameter, and $\frac{1}{80}$ inch (0.1 mm.) in thickness, which closes the inner end of the

external auditory meatus, and separates it from the tympanum. It is attached by its margin to a distinct grooved ridge—the *sulcus tympanicus*—which runs round the bottom of the meatus. The external surface of the membrane looks *in general* outward, downwards, and forwards, making an angle of about 45° with both the horizontal and sagittal planes. On account of this obliquity and the downward slope of the floor of the meatus, the membrane and the floor meet at a sharp angle (27°), and form thereby a pond or hollow ‘recessus’ at the

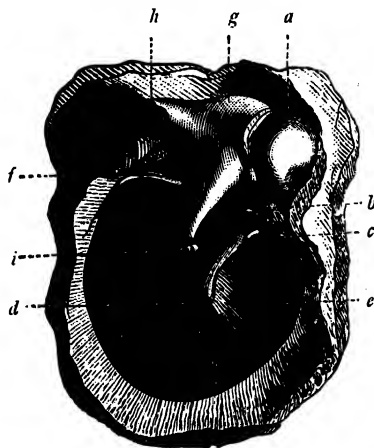


FIG. 4.—INTERNAL SURFACE OF LEFT MEMBRANA TYMPANI, ENLARGED.

a, Head of the malleus; *b*, neck of the malleus; *c*, tendon of the tensor tympani; *d*, inferior extremity of the handle of the malleus; *e*, anterior portion of the membrana tympani; *f*, fold of the membrana tympani containing the chorda tympani; *g*, incus; *h*, short process of the incus; *i*, long process. (After Politzer.)

inner end of the meatus, in which foreign bodies often lodge. As a further result of this obliquity of the membrane its lower part is about 6 mm. further from the orifice of the meatus than the upper part.

By its inner surface (Fig. 4) the membrana tympani gives attachment to the malleus, the long process or handle of which runs downward and backward between the fibrous and mucous layers to a point below the centre of the membrane. At the upper end of the handle is situated the short process of the malleus, which abuts against

and forms a distinct projection on the outer surface of the membrane. From this projection run backwards and forwards respectively two ridges, the **anterior** and **posterior tympanic folds** (**Prussak's striæ**). These, taken together, form a nearly straight line, the anterior extremity of which is about 2 mm. lower than the posterior. The sulcus tympanicus, the grooved ridge of bone into which the membrana tympani is inserted, is interrupted above and somewhat in front by a notch, the incisura Rivini. The portion of the membrana tympani which fills in the incisura Rivini is known as the *membrana flaccida*, or *membrana Shrapnelli*, and it is marked off from the rest of the tympanic membrane below by the anterior and posterior tympanic folds first mentioned. The membrana Shrapnelli differs from the rest of the tympanic membrane in that it is very loosely stretched; hence the name *membrana flaccida* commonly given to it. It is concave towards the meatus, but by forcing air into the tympanum through the Eustachian tube, the concavity may be changed to a protrusion.

The whole membrane is funnel-shaped, the concave surface being directed outwards towards the meatus, and the bottom or apex of the funnel, known as the *umbo*, corresponding to the lower extremity of the malleus.

The depth of the funnel is about 2 mm. (Siebenmann). For the purpose of description the membrane is divided into four parts or quadrants by two lines, one corresponding in direction to the hammer-handle, and the other passing through the umbo at right angles to the first. Thus we have four quadrants, of which the posterior superior is the largest and the anterior inferior the smallest.

The membrane is irregularly oval in outline, the longest diameter being directed downwards and forwards, and measuring 9·22 mm., whilst the short transverse axis is 8·5 mm. (Bezold; Tröltsch).

The **auroscopic appearance** is described at p. 40.

Structure.—The membrana tympani is composed of three layers—namely, a central supporting sheet, covered outside by skin, and inside by mucous membrane. The outer layer is simply a continuation of the skin of the meatus, but it is very thin and delicate, both as regards epithelium and corium. The central layer, or *membrana propria*, is made up of fibrous

tissue, the fibres of which are mainly radial in direction; starting from the handle of the malleus, and particularly from the umbo, they pass out on all sides to the sulcus tympanicus. On the inner surface of the radial fibres there are others circularly disposed, but these are comparatively few in number, and are situated chiefly at the periphery. The handle of the malleus is closely adherent to the inner surface of this layer, the periosteum of the bone passing continuously into it. The inner layer consists of the mucous membrane of the tympanic cavity, here covered by a simple layer of flattened epithelial cells. The chorda tympani nerve passes across the upper part of the membrana, covered in by a reduplication of the mucous membrane (as described below), and may often be faintly seen in the living subject from the external auditory meatus.

The membrana tympani has two systems of *bloodvessels*, situated respectively in the skin and the mucous layer, and these systems are connected together by perforating branches, which pierce the membrana propria chiefly at the periphery of the membrane. The artery for the skin is derived from the deep auricular branch of the internal maxillary; it descends with two companion veins from the roof of the meatus on to the surface of the membrane, and passes down close behind the handle of the malleus as far as the umbo, where it breaks up into a large number of radial branches. The arteries of the mucous layer are derived chiefly from the stylo-mastoid artery and the tympanic branch of the internal maxillary. There are *lymphatic vessels* or spaces in all the layers of the membrana, and the lymphatic glands around the insertion of the sterno-mastoid muscle are probably the first to receive its lymph (Langer).

The Middle Ear or Tympanum.

The **Tympanum** is an irregular, six-sided cavity situated in the temporal bone, immediately internal to the membrana tympani, above the level of which latter, however, it extends for a considerable distance (Fig. 1). It communicates behind through the antrum with the mastoid cells, and in front through

the Eustachian tube with the pharynx. The tympanic cavity is practically a slit-like space, the long axis of which is continuous with that of the Eustachian tube in front and of the mastoid antrum behind; and a straight line drawn through the Eustachian tube will pass through the length of the cavity and on into the antrum (Schwalbe). The outer and inner walls are the most extensive; they are not perpendicular, but are both inclined outwards above. The whole cavity is wider above than below, for the outer wall, formed



FIG. 5.—INNER ASPECT OF THE OUTER HALF OF THE TEMPORAL BONE EXPOSED BY A VERTICAL SECTION MADE ANTERO-POSTERIORLY THROUGH THE TYMPANUM, ANTRUM MASTOIDEUM, AND MASTOID CELLS.

- A, Antrum mastoideum; B, mastoid cells; C, inner surface of tympanic membrane; D and E, head of malleus and body of incus; F, chorda tympani nerve; G, fossa for jugular vein; H, partition of bone between the cavity of the tympanum and the antrum mastoideum (below the letter H a portion of the canal for the facial nerve is shown); I, dura mater. (After Barr.)

chiefly by the membrana tympani, is more oblique than the inner wall (Fig. 1).

The **roof** consists of a thin plate of bone, the *tegmen tympani*, separating the tympanum from the cranial cavity. Minute bloodvessels pass through the tegmen, from the tympanum to the dura mater, which latter sometimes becomes involved in inflammatory conditions of the middle ear.

The **floor** is not sharply separated from the anterior and posterior walls, but slopes gradually upwards into these; it contains a large number of small depressions, separated by transverse ridges. These little cavities vary much in depth,

and are called the tympanic cells. At the inner margin of the floor is a small foramen for the passage of the tympanic branch (Jacobson's) of the glossopharyngeal nerve. The floor corresponds in position to part of the roof of the jugular fossa, the separating layer of bone being very thin in the infant, but thicker in the adult (Schwalbe). Its thickness is very variable, however, and sometimes it may be partly absent, so that the bulb of the jugular vein (lateral sinus) actually projects into the cavity of the tympanum through the floor (Zuckerkindl).

The **outer wall** is formed chiefly by the membrana tympani, but the tympanum extends both upwards and downwards

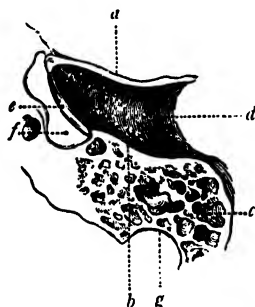


FIG. 6.—HORIZONTAL SECTION OF THE EXTERNAL MEATUS AND TYMPANIC CAVITY.

a, Anterior wall of the meatus; *b*, posterior; *c*, cells of the mastoid process; *d*, meatus; *e*, membrana tympani; *f*, tympanic cavity; *g*, fossa sigmoidea. (Right ear.)

(in the latter direction to a distance of 3 mm.) beyond the limits of the membrane. Close to the margin of the membrana, at its upper and anterior part, is the inner end of the Glaserian fissure, which leads to the glenoid fossa. This fissure lodges the processus gracilis and the anterior ligament of the malleus, and transmits the anterior tympanic artery.

The *chorda tympani nerve* (Fig. 5), which springs from the facial a little distance above the stylo-mastoid foramen, enters the tympanum behind, and then crosses the inner surface of the membrana, lying beneath its mucous layer, and running between the handle of the malleus and the long process

of the incus; finally, it leaves the cavity through a small passage in the anterior tympanic wall, known as the canal of Huguier.

The **anterior wall** presents the large opening of the Eustachian tube, the lower margin of which is situated about 4 mm. above the tympanic floor.

The ascending part of the *carotid canal*, containing the internal carotid artery, is separated from the tympanum by the thin anterior wall, measuring here only 1 or 2 mm. thick. This is an important relation, particularly as in rare cases the separating wall is deficient (Zaufal), when the carotid artery is separated from the tympanum by mucous membrane only, and possibly may be wounded in paracentesis of the membrana. The canal for the tensor tympani muscle lying above the Eustachian tube opens on the inner wall of the cavity.

The **posterior wall** presents, at a distance of about 6 mm. above the floor, the large triangular opening of the *mastoid antrum*, immediately beneath which the short process of the incus is fixed (Fig. 5). Below, and internal to this, is situated the *pyramid*, a hollow, conical process of bone containing the stapedius muscle, the tendon of which escapes at its apex, and is inserted into the neck of the stapes. Below the opening of the antrum, and close to the sulcus tympanicus, is a depression, the *sinus posterior*; to the outer side of this is situated the *iter chordæ posterius*, through which the chorda tympani nerve enters the tympanum.

The **Inner Wall** of the tympanum corresponds to the outer wall of the labyrinth, into which latter the two fenestræ on this wall open. In front it presents a rounded elevation known as the *promontory*, which occupies the central and lower portions of the wall, and is formed by the projection outwards of the first turn of the cochlea. Above and behind this is the *fenestra ovalis* (situated at the bottom of a depression known as the pelvis ovalis), which leads into the vestibule, and in the recent state is occupied by the base of the stapes. Below the fenestra ovalis, and separated from it by the posterior part of the promontory, is the *fossa of the fenestra rotunda*. This fossa is a deep concavity, running upwards and inwards, and leading to the fenestra rotunda, which latter lies at its

bottom almost completely hidden beneath the downward projecting ridge of the promontory, which overhangs the fossa above. The fenestra rotunda leads into the scala tympani of the cochlea, and is completely closed in the recent state by the *secondary membrane of the tympanum*. This membrane resembles in structure the membrana tympani proper, consisting, like it, of a central fibrous layer covered on the outside by the mucous membrane of the tympanum, and on the inside by the endothelial lining of the cochlea.

Above the fenestra ovalis, and close to the roof of the tympanum, is a curved elevation which corresponds to the *facial canal* (aqueduct of Fallopius).

Between the two fenestræ, and somewhat behind them, is a deep (3 mm.) depression, the *sinus tympanicus*, which is bounded above and behind by the ridge of the facial canal. It is placed directly in front of the pyramid, the sharp apex of which projects over the sinus, to be connected to the promontory by a bridge of bone as a rule. The bottom of the sinus corresponds to the ampullary end of the posterior semicircular canal.

The surface of the promontory shows a faint groove running upwards from the floor, which lodges Jacobson's nerve—the tympanic branch of the glosso-pharyngeal—for the supply of the mucous membrane of the tympanum and of the mastoid cells. This nerve, with its connections, forms the tympanic plexus.

The *facial nerve* in its passage through the temporal pursues the following course: (1) It first runs outward through the internal auditory meatus, at the bottom of which it enters the aqueduct of Fallopius, or facial canal. (2) Continuing this outward course, and passing between the vestibule and cochlea, it approaches the inner wall of the tympanum, where it bends abruptly backwards and has developed upon it the geniculate ganglion. (3) It next runs backwards in its canal along the inner angle of the roof of the tympanum, just above the fenestra ovalis, and then passes down behind that cavity—here lying just internal to the opening of the mastoid antrum,—to make its exit at the stylo-mastoid foramen.

The ridge formed by the facial canal is a prominent object,

as it arches backwards and downwards over the fossa ovalis, at the upper part of the inner wall of the tympanum.

The upper division of the tympanum, namely, the portion lying above the membrane (Fig. 1), is described separately by some authors (Bezold; Schwalbe) under the name of the **attic**, the recessus epitympanicus, or the aditus ad antrum (for the antrum opens into it). The outer wall of the **attic** corresponds to the inner end of the mass of bone which forms the roof of the external auditory meatus—here sloping downwards—and also to the membrana Shrapnelli below. Its cavity passes backwards, without marked narrowing, into the antrum, the elevated ridge of the facial canal forming on the inner wall a division or threshold between the two.

The **Mastoid Antrum** (Fig. 7) is a somewhat bean-shaped cavity, flattened from side to side, situated between the tympanum in front and the mastoid cells behind. Through it the mastoid air-cells communicate with the tympanic cavity. Its average length (from before, backwards and outwards) is about 12 mm., its vertical measurement 8.5 mm., and its horizontal width 6.7 mm. It is present in the child at birth, although the mastoid cells have not yet been formed. The walls of almost the entire antrum are covered with small depressions or openings of various sizes, which lead into a complicated and generally extensive system of pneumatic cavities, hollowed out in the mastoid and petrous portion of the temporal bone, and known as the mastoid cells.

The **Mastoid Cells** (Fig. 7) spread out in the substance of the bone to a very variable degree, in some cases being so extensive that they reach forward as far as the root of the zygoma, upwards for some distance between the layers of the squamous, and also outwards close to the roof and posterior walls of the external auditory meatus. They may extend downwards to the lowest part of the mastoid process, so that there is only a paper-like layer of compact bone separating them from the periosteum both on the outer and inner sides of the process. In such cases there may be only the same thin layer of bone separating the cells from the lateral sinus internally. On the other hand, the air-containing cells are sometimes confined to

a small space, situated in the upper part of the mastoid, the greater part of the latter being either cancellous, or solid, compact bone. About 20 per cent. (Zuckerkandl) of mastoids contain no air-cells, being solely composed of either diploic or compact tissue. The mastoid cells are lined throughout by mucous membrane continuous with that of the tympanum. °

The **Auditory Ossicles** (Fig. 1), which are situated in the tympanum, are three in number: the malleus, the incus, and the stapes.

The **Malleus**, or hammer, is about 18 mm. long, and presents an upper expanded part or head (supported on a neck), which articulates behind with the incus, a lower slender and tapering portion, the handle, and two processes. The handle, directed downwards, backwards, and inwards, lies in contact with the membrana tympani, to the fibrous layer of which it is closely adherent. At the junction of the handle with the neck is the short process, which is directed outwards against the membrana tympani, just below the membrana Shrapnelli. It forms an important projection on the outer surface of the membrane. The long process, or processus gracilis—in great part fibrous in the adult—is very slender, projects forwards, and ends in the beginning of the Glaserian fissure.

The **Incus** lies behind, and somewhat internal to, the malleus. It consists of a body—showing a facet in front for articulation with the malleus—and two processes. The long process runs downwards, parallel to the handle of the malleus, behind and internal to which it lies, and bears on the inner side of its extremity the orbicular process, which articulates with the head of the stapes. The short process is directed backwards, and is movably attached to the posterior wall of the tympanum just below the opening of the antrum.

The **Stapes**, very small and slender, is shaped like a stirrup. It has a head directed outwards for articulation with the orbicular process of the incus, and two crura which connect the head to the base or foot-piece. This latter is an irregularly oval plate of bone fitting into, and almost filling, the fenestra ovalis, to the margins of which it is attached all around by a strong elastic ligament..

The head of the malleus is connected to the body of the incus, and the orbicular process of the incus to the head of the stapes respectively, by synovial joints.

Movements of the Ossicles.—When, during its vibration, the membrana tympani moves inwards, it carries with it the malleus, which is intimately united to its fibrous layer. This movement is transmitted by the malleus to the incus, the long process of which is carried inwards against the head of the stapes, the final result being that the base of this latter bone is pressed into the fenestra ovalis (whilst the secondary membrane of the tympanum bulges outwards at the same time to relieve the pressure of the fluid within the labyrinth). Thus the vibrations of the membrane are transmitted across the middle ear to the labyrinth by the chain of bones in that cavity.

Folds and Pouches of the Tympanic Mucous Membrane.—Several folds and pouches have been described, but only one of these, Prussak's pouch or space, need be referred to here as of practical importance. This small pouch lies just above the short process of the malleus, and is placed between Shrapnell's membrane externally and the upper portion of the malleus internally. It is almost completely shut off by mucous and ligamentous folds from the tympanic cavity, into which, however, it usually opens above and behind. Its interest lies in the fact that it is a common seat of purulent inflammatory processes, and into it perforations of Shrapnell's membrane open.

The **Eustachian Tube** (Fig. 7) passes from the nasopharynx to the tympanum, to which latter it admits air. It usually measures about $1\frac{1}{2}$ inches (36 mm.) in length, and is made up of an outer bony and an inner cartilaginous part, the latter constituting two-thirds of the entire length. The whole tube may be compared in shape to two narrow cones or trumpets—an inner larger and an outer smaller—with their apices joined; at the junction of the two its diameter is about $\frac{1}{12}$ inch (2 mm.). The tube runs inwards, forwards, and downwards from the tympanum to the pharynx (making an angle of 45° to 50° with the sagittal plane, and one of about 30° with the horizontal plane).

The cartilaginous portion is formed of a somewhat triangular plate of cartilage folded upon itself so as to form a channel, open below and in front where it is completed by fibrous tissue, to which some fibres of the tensor palati muscle are attached (dilator tubæ Rüdinger).

The pharyngeal opening of the tube is situated on the side-wall of the naso-pharynx, and is fully described in the account of that cavity (see pp. 32, 43).

The osseus portion, narrower than the cartilaginous, runs in the angle between the petrous and squamous

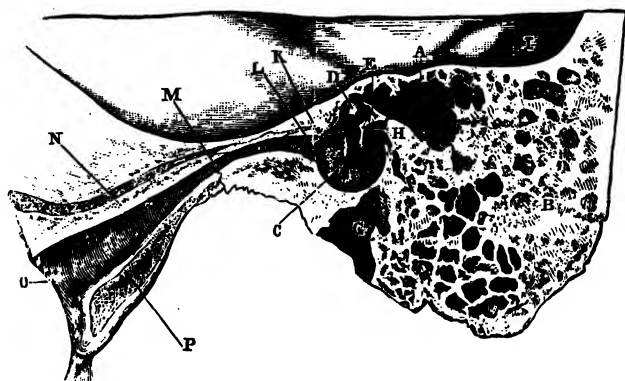


FIG. 7.—SECTION THROUGH THE WHOLE EXTENT OF THE MIDDLE EAR.

- A, Antrum mastoideum; B, mastoid cells; C, inner surface of tympanic membrane, at lower end of manubrium; D, head of malleus; E, body of incus; G, fossa for jugular vein; H, partition of bone between the cavity of the tympanum and the antrum mastoideum (below the letter H a portion of the canal for the facial nerve is shown); I, dura mater; K, chorda tympani nerve; L, tympanic mouth of Eustachian tube; M, isthmus of the Eustachian tube; N and P, walls of cartilaginous part of Eustachian tube; O, pharyngeal mouth of Eustachian tube. (After Barr.)

divisions of the temporal bone, below the canal for the tensor tympani muscle. Its narrow inner end is united to the cartilaginous portion, while its wider outer extremity opens on the anterior wall of the tympanum, as already described.

The whole tube is lined by mucous membrane, which in the bony part is thin and continuous with that of the tympanum, but in the cartilaginous part it is thicker, and contains mucous glands and some adenoid tissue. At the pharyngeal

orifice it passes into the mucous membrane of the pharynx. The mucous membrane throughout is covered by columnar ciliated epithelium.

The Internal Ear.

The internal ear is situated in the petrous portion of the temporal bone, immediately internal to the tympanum, and consists of a series of bony passages known as the *osseous labyrinth*, containing a corresponding series of membranous structures, known collectively as the *membranous labyrinth*. The space between the membranous and bony labyrinths is occupied by a lymph-like fluid called the *perilymph*, whilst

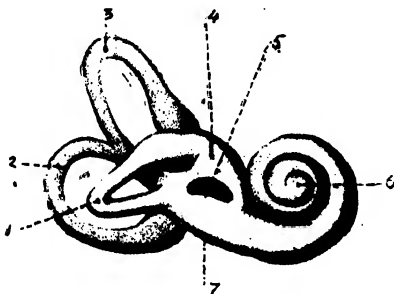


FIG. 8.—THE RIGHT OSSEOUS LABYRINTH. (Viewed from the outer side.)

1, External semicircular canal; 2, posterior canal; 3, superior canal; 4, vestibule; 5, fenestra ovalis; 6, apex of cochlea; 7, fenestra rotunda

the membranous labyrinth contains a similar fluid, the *endolymph*, in addition to the essential portions of the organ of hearing.

The **Osseous Labyrinth** (Fig. 8) consists of three parts, namely: (1) The vestibule, a central oval cavity nearly as large as a half-pea, on the outer wall of which is situated the fenestra ovalis, whilst through its inner wall pass branches of the auditory nerve. (2) Running forwards from the vestibule, and then turning upwards, is a bony tube, which is coiled in the form of a shell around a central core, known as the *modiolus*. This is the **cochlea**, and its base, through which numerous branches of the auditory nerve enter, corresponds to the bottom of the internal auditory meatus. The fenestra

rotunda of the tympanum opens into the beginning of the tube of the cochlea. (3) Finally, into the upper and posterior portion of the vestibule open three arched bony tubes (each about $\frac{3}{4}$ inch long and $\frac{1}{8}$ inch in diameter), termed the **semicircular canals**. Two of these are placed vertically and at right angles to one another; the third lies horizontally and external to the other two. This latter comes into close relation with the inner wall of the mastoid antrum, and may be injured in operations on that cavity.

The **Membranous Labyrinth**, like the preceding, is made up of three divisions: the membranous vestibule, the



FIG. 9.—THE MEMBRANOUS LABYRINTH, CORRESPONDING TO THE OSSEOUS LABYRINTH SHOWN IN FIG. 8.

- 1, External semicircular canal; 2, posterior canal; 3, superior canal; 4, utricle; 5, saccule; 6, membranous canal of cochlea; 7, canalis reuniens; 8, ductus endolymphaticus.

membranous semicircular canals, and the membranous canal of the cochlea (Fig. 9).

The **Membranous Vestibule** consists of two sacs, an upper known as the *utricle*, into which the semicircular canals open; and a lower, the *saccule*, which is connected with the membranous canal of the cochlea by a very narrow duct (the canalis reuniens). The utricle and saccule are also indirectly connected by a Y-shaped tube (the ductus endolymphaticus). Thus the several divisions of the membranous labyrinth are brought into communication, and the contained endolymph can pass from one part to another without interruption.

At one point (known as the *macula acustica*) the epithelium of the inner wall of both utricle and saccule, which elsewhere is flattened, is made up of columnar cells, amongst the bases of which fibres of the auditory nerve ramify, whilst from the free end of each cell a stiff, hair-like process projects into the cavity. (The cells are consequently known as hair-cells). Over each macula, with its projecting hairs, lies a little mass of calcareous particles (otoliths), imbedded in a soft matrix. Vibrations of the endolymph are supposed to affect the hairs or the hair-cells (possibly through the impact of the otoliths), giving rise to impressions which are conveyed to the brain by the auditory nerve fibres. A somewhat similar 'macula' is found at one end of each semicircular canal (where it is called a *crista acustica*).

The **Membranous Semicircular Canals** correspond to the bony tubes within which they lie, but are very much narrower. Like the osseous canal, each presents at one end a dilatation, the ampulla, within which is found a *crista acustica*, connected with fibres of the auditory nerve, as in the case of the maculæ of the utricle and saccule.

There seems to be no doubt that the semicircular canals have no real connection with the function of hearing, but that in some way they minister to the mechanism for the co-ordination of bodily movements, either by afferent impulses constantly passing from them to the cerebellum, or otherwise. And, apparently to facilitate the taking up of impressions resulting from movement in any direction, the canals are disposed in the three planes of space, one being horizontal and the two others vertical, but at right angles to one another. When the head moves in any direction, the pressure of the endolymph is disturbed in one or more canals, and this, affecting the hair-cells of the macula, sets up an impression which is conveyed by (a division of) the auditory nerve to the brain.

The Membranous Cochlea.—The coiled bony tube of the cochlea is divided longitudinally into three passages or *scalæ*, namely, the *scala tympani*, the *scala vestibuli*, and the *scala media* or membranous canal of the cochlea (Fig. 10).

The division is effected by two partitions. One of these is formed in part by a spiral ledge or shelf of bone, known as the bony spiral lamina, which projects into the tube from the bony core (modiolus) of the cochlea, but does not extend across its whole width. The partition is completed by the *basilar membrane* (an exceedingly important structure, made up

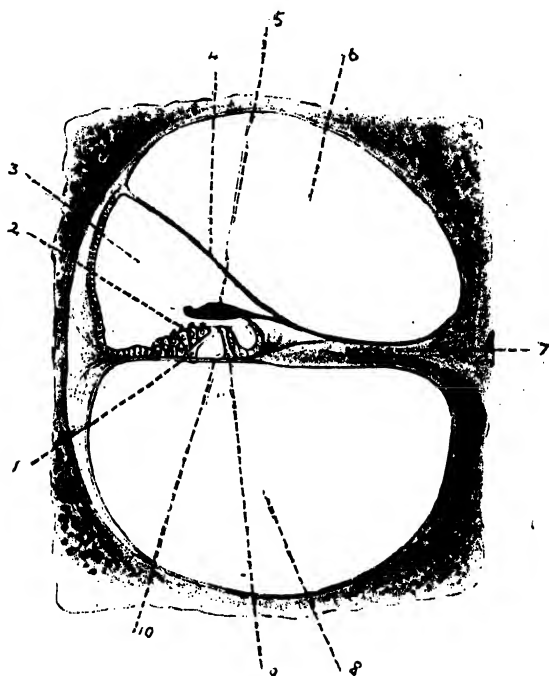


FIG. 10.—TRANSVERSE SECTION THROUGH THE TUBE OF THE COCHLEA.

- 1, Outer rod of Corti; 2, outer hair-cells; 3, membranous canal of cochlea (scala media); 4, membrane of Reissner; 5, tectorial membrane; 6, scala vestibuli; 7, osseous spiral lamina; 8, scala tympani; 9, inner rod of Corti; 10, basilar membrane.

largely of radially-disposed fibres), which extends from the bony spiral lamina to the outer wall of the cochlea.

The second partition, the extremely delicate membrane of Reissner, crosses the tube from the upper surface of the bony spiral lamina near its edge to the outer wall of the cochlea, above the attachment of the basilar membrane. Between the basilar membrane and the membrane of

Reissner lies the scala media; above it (*i.e.*, on the side nearest to the apex of the cochlea) is the scala vestibuli, and below it the scala tympani (see Fig. 10). These two latter communicate with one another (through the helicotrema) at the apex of the cochlea. Below, the scala tympani is separated from the tympanum at the fenestra rotunda by the secondary membrane only, whilst the lower end of the scala vestibuli is continuous with the vestibule, so that the perilymph, which occupies the vestibule and the two scalæ, is continuous throughout all these parts.

The *scala media*, or *membranous canal of the cochlea*, is triangular in shape on section, the two sides being formed by the membrane of Reissner and basilar membrane respectively, and the base by the periosteum of the outer wall of the cochlea. In this division of the cochlea, and resting on the basilar membrane, is situated the highly specialized part of the ear known as the organ of Corti.

The *organ of Corti* is formed of a number of modified epithelial cells resting upon the basilar membrane, amongst which the terminal branches of the cochlear nerve ramify. It consists essentially of the following parts: (a) The *rods of Corti*, inner and outer, two rows of very much elongated, and otherwise modified epithelial cells, which are united above by their heads, whilst their bases are separated by some distance, and rest upon the basilar membrane. Between the two rows, each of which consists of about 3,000 rods, there is thus formed a long passage (known as the tunnel of Corti). (b) The *hair-cells*. These are columnar epithelial cells which lie against the inner and outer rods of Corti respectively. The upper ends of the cells come to the surface, and are there capped by tufts of small hair-like processes (hence the name of the cells), whilst the terminal filaments of the cochlear nerve ramify amongst their bases. In man there is but one row of inner hair-cells, but there are several rows of outer cells placed external to the outer rods of Corti. (c) The *cochlear nerve*, a branch of the auditory, sends its fibres from the bottom of the internal auditory meatus up through the central column (modiolus) of the cochlea; thence they pass out through

canals in the spiral lamina, each having a ganglion developed upon it: finally they end in arborizations around the bases of the hair-cells. (d) Over the whole of the organ of Corti lies a peculiar structure known as the *tectorial membrane* (see Fig. 10), which is attached internally to the (limbus of) the spiral lamina, and is free externally. It is supposed to act as a damping mechanism in connection with the hair-cells.

As already pointed out, the membranous canal of the cochlea is occupied by endolymph, continuous with that of the membranous vestibule, whilst the scala tympani and scala vestibuli are occupied by perilymph, continuous with that in the vestibule.

Summary of the Physiology of Hearing.

The following is a brief statement of the chief facts connected with the perception of sounds:

1. Sounds are produced by the vibration of sounding bodies—*e.g.*, violin strings, drums, bells, etc.

2. The vibrations of the sounding body are communicated to the surrounding air, in which corresponding vibrations, known as 'sound-waves,' are set up.

3. These sound-waves, having previously been, to some extent, collected by the pinna, impinge upon the tympanic membrane, and throw it into a state of vibration.

4. The vibrations set up in the membrane are conveyed across the tympanum by the auditory ossicles, the three bones forming, as it were, an osseous chain stretching across the cavity. The inner end of this chain, represented by the base of the stapes, fits into the fenestra ovalis, and there comes into relation with the perilymph of the internal ear, to which the vibrations are communicated.

5. The vibratory waves thus set up in the perilymph, running along the scala vestibuli and scala tympani, break upon the basilar membrane and the membrane of Reissner, and throw them, as well as the contained endolymph of the scala media, into vibration.

6. Finally, the vibrations of the basilar membrane and the endolymph extend to the hair-cells, and set up in these

stimuli, which are conveyed by the fibres of the cochlear nerve to the brain, and there give rise to auditory sensations.

To this short statement the following additional points may be added :

The external ear is of very little use as a collector of sound-waves in man, although in certain animals it is of considerable importance in this respect.

- The membrana tympani must not be looked upon as an ordinary tightly-extended drumhead, which only vibrates to its own fundamental note. On the contrary, it is not flat, but funnel-shaped ; it is neither tightly nor evenly stretched ; it can be rendered more or less tense by the contraction and relaxation respectively of the tensor tympani muscle ; and the chain of ossicles attached to its inner surface act, to some extent, as a damper of its vibrations. In a word, it is a living, not a dead, membrane, and it is capable of responding, not only to its own fundamental note, but to a series of tones extending over seven octaves.

The uses of the Eustachian tube in connection with hearing are two. In the first place, it constitutes an outlet for the mucus secreted by the tympanic mucous membrane. Secondly, it admits air to the tympanum, for it is necessary to the perfect action of the tympanic membrane that the pressure of the air on its two sides should be equal. If that in the tympanum becomes much rarefied, the greater pressure of the external air will drive the membrane inwards, thus rendering it too tense and interfering with its working. The deafness resulting from this condition is known as 'throat deafness.' It arises from a blocking of the Eustachian tube, often found in connection with throat troubles. As a result of the blocking, no renewal of the tympanic air can take place, whilst that already contained in the cavity becomes rarefied owing to the absorption of its oxygen by the blood in the capillaries of the mucous membrane, which gives out in exchange a smaller quantity of carbonic acid gas. Excessive tension of the membrane, giving rise to deafness, is the result, as already explained, but this deafness can be relieved at once by passing a Eustachian catheter. Under ordinary conditions air is admitted to the tympanum

every time the act of swallowing takes place; this is due to the fact that the Eustachian tube is rendered patent by the contraction of the levator palati muscle.

Although the three ossicles vibrate practically as if they were one bone, it is, however, an important fact, upon which much depends, that they are connected to one another by slightly movable joints, which give elasticity to the chain, and to some extent cut off excessive vibrations of the membrane. On this account ankylosis of the joints gives rise to disturbance of function. It is also of interest to remark that the vibratory molecular movements of the air and membrana tympani are converted into a lever movement of the ossicles; what is lost in speed and range being gained in force.

The use of the fenestra rotunda and the secondary tympanic membrane is, as it were, to provide a 'vent' for the labyrinth and its contained fluid, so that when the vibrations of the tympanic membrane are conveyed to the tympanic bones, and the base of the stapes is pressed inwards, the secondary membrane, bulging slightly outwards, relieves the pressure, and gives space in the vestibule for the incursion of the stapes. Were the foramen and secondary membrane absent, the propagation of the vibrations through the perilymph would be impossible.

Two chief views are held as to the function of the cochlea; they are known respectively as the 'piano theory' of Helmholtz, and the 'telephone theory' of Rutherford and Waller.

In the **piano theory** it was supposed that the various rods of Corti were attuned, as it were, to different notes, in response to which they were thrown into vibration, just as when a note is sounded in front of a piano certain strings vibrate in response. Subsequently Helmholtz changed this view about the rods of Corti—for in man the pairs of rods are not as numerous as the varieties of pitch which can be recognised by a well-trained ear; besides, the rods are absent in birds—and he substituted for them the fibres of the basilar membrane. Some of these were said to be thrown into sympathetic vibration by each note; this affected the hair-cells in the vicinity and gave rise to stimuli, which were conveyed to the brain by the auditory nerve fibres.

In the **telephone theory**, on the other hand, it is not supposed that *special parts* of the organ of Corti or of the basilar membrane vibrate in response to special notes, but that the *whole* basilar membrane vibrates to every note, like the tympanic membrane, or the membrane of a telephone, the vibrations being at different rates for different notes, and possibly varying in their character in different parts of the membrane. As a result, all the hair-cells are affected, and a complex impression is conveyed by the auditory nerve to the brain, where the analysis of the sound takes place.

The chief difference between the two views is that in the piano theory the analysis of the sound is supposed to take place in the cochlea by the sympathetic vibration of corresponding fibres of the basilar membrane, whilst in the telephone theory a complex impression, like that from the tympanic membrane, is sent by the basilar membrane, and the organ of Corti as a whole, to the brain, and is there analyzed.

The course pursued by the auditory impressions on their way to the brain is briefly as follows : They reach the medulla through the cochlear nerve ; passing up, they establish communication with the inferior olive in the lower part of the pons, and here the majority decussate (in the trapezium of the pons). They next ascend in the lateral fillet of both sides, establish connections with the cells of the inferior quadrigeminal bodies, and, passing through the posterior part of the internal capsule, reach the superior temporal convolution, which is generally believed to be the cortical centre for hearing.

The Naso-Pharynx.

Owing to its close connection, through the Eustachian tube, with the middle ear, it will be necessary to briefly describe the upper portion of the pharynx, which is known as the naso-pharynx (Fig. 11).

The **Naso-Pharynx** differs from the rest of the pharynx in that its cavity under all conditions remains open, and forms a chamber of considerable size, incapable of obliteration. This results from the fact that all its walls are

immovable except the floor, which latter is formed by the soft palate.

It communicates with the nasal cavities in front, by the **posterior nares**—two oblong apertures, separated by the vomer, each measuring 1 inch (25 mm.) from above downwards, and $\frac{1}{2}$ inch (12.5 mm.) from side to side—which occupy the whole of its anterior wall. The floor is formed by the soft palate, but behind the palate the cavity communicates with the lower portion of the pharynx through the **pharyngeal isthmus**—an aperture of variable size, placed between the two posterior palatine arches ('posterior pillars of the fauces')—through which the naso-pharynx can be explored from the mouth with the finger. During the act of swallowing, the isthmus is closed by the ascent of the soft palate and the approximation of the posterior palatine arches; the food is thus prevented from entering the nose. Advantage is taken of this fact in Politzer's method of inflating the tympanum (see p. 92).

The greater part of each lateral wall of the naso-pharynx is occupied by the orifice of the Eustachian tube, with its prominent 'cushion' bounding it above and behind. Behind this on the lateral wall is seen a vertical slit-like depression, which leads into a flattened diverticulum, known as the **lateral recess of the pharynx**, or fossa of Rosenmüller.

The **Orifice of the Eustachian Tube** is usually triangular (with the base downwards), sometimes slit-shaped, but it always presents a characteristic infundibular or funnel-like appearance (Fig. 11). This results from the fact that the Eustachian cartilage, which partly surrounds the inner portion of the tube, projects as a prominent ridge around the upper and posterior aspect of the opening; the ridge is known as the **Eustachian cushion**. The presence of this firm ridge lying behind the orifice, coupled with the absence of any such projection in front, greatly facilitates the passage of a Eustachian catheter. Should the catheter slip back over the cushion, it will enter the lateral recess of the pharynx, which is of considerable depth.

The exact position of the Eustachian orifice is of importance; it is placed on the side-wall of the pharynx, a little

way ($\frac{1}{3}$ to $\frac{1}{2}$ inch : 8 to 12·5 mm.) above the hard palate, and behind the posterior end of the inferior turbinated bone, or, according to Tillaux, $\frac{1}{2}$ inch (12·5 mm.) above and behind the margin of the hard palate.

On the upper part of the posterior wall, above the level of the Eustachian orifices, there is found, particularly in the child, a considerable accumulation of lymphoid tissue, known as the **pharyngeal tonsil** of Luschka. In old age this lymphoid tissue almost completely disappears, whilst in the child it is often enormously increased in amount, and gives rise to 'adenoids.'

The Nasal Cavities and the Air-cells connected with them.

Only a brief account of these parts need be given, as they are but indirectly connected with the subject proper of this work.

The **Nasal Fossæ** are two narrow, irregular spaces, strongly flattened from side to side and elongated antero-posteriorly, which lead from the anterior nares in front to the posterior nares behind. The two fossæ are separated from one another by the nasal septum, and into them open the nasal ducts—which convey the tears from the eyes to the inferior meatus—the ethmoidal cells, the frontal, sphenoidal, and maxillary sinuses. Each extends up to the base of the skull and down to the hard palate; it opens behind through the posterior nares into the naso-pharynx, and in front communicates through the nostril with the exterior. Finally, the outer wall of each fossa presents the three scroll-like turbinated bones projecting into the cavity, below which are seen three horizontal grooves—the superior, middle, and inferior meatuses of the nose.

The portion of the nasal cavity immediately above the aperture of the nostrils is known as the *vestibule*, and is covered by a prolongation of the squamous epithelium of the skin.

The **Nasal Septum** is formed by the vomer below and behind, by the vertical plate of the ethmoid above, and by

the septal cartilage of the nose in front. It rarely adheres to the middle line, but is in the majority of cases deflected to one or the other side. Often these deflections, which are found in both the bony and cartilaginous portions, are so marked and so abrupt as to look like outgrowths of the septum. Deflections limited to the cartilage are apparently due to excessive growth of the latter, and can hardly be regarded as pathological, as they are present in the majority of cases. Very commonly bony projections, known as 'spurs,' are found along the line of junction of the vomer and the ethmoid.

The roof of the nasal fossæ is in immediate relation to the cavity of the cranium, from which it is separated in its middle portion by the very thin cribriform plate of the ethmoid only; through this plate the olfactory nerve-fibres reach the cavity.

As regards the floor, it need only be said that it is horizontal from before backwards, and is limited anteriorly by an elevated ridge, forming a kind of threshold (4 or 5 mm. in height), which to some extent hides the anterior part of the inferior meatus from view, until the nostril is drawn well upwards. The edge of this threshold lies some distance (nearly $\frac{1}{4}$ inch, 6 or 7 mm.) above the level of the aperture of the nostrils.

Superiorly, the nasal fossa, here slit-like in character, lies between the lateral mass of the ethmoid and the vertical plate of that bone, so that the lateral mass, with its two turbinated bones, forms the outer wall of the fossa in its upper part. Lower down this wall is formed by the superior maxilla and palate bones, with the inferior turbinal running along them. The chief objects of importance on the outer wall (Fig. 11) are the three turbinated bones, with the three meatuses lying beneath them, and the orifices of the air cavities which communicate with the nose.

The **Superior Turbinal** is small and unimportant; it is confined to the upper and posterior portion of the fossa, and is practically out of reach of the surgeon. The same may be said of the **superior meatus**, which lies beneath it, and into which the posterior ethmoidal cells open.

The **Middle Turbinated Bone**,* although shorter, is usually wider and more prominent than the inferior turbinal, from which it is separated by the middle meatus. In shape it is an elongated triangle with its base forwards. The lower border is free and rounded; the upper is attached; whilst

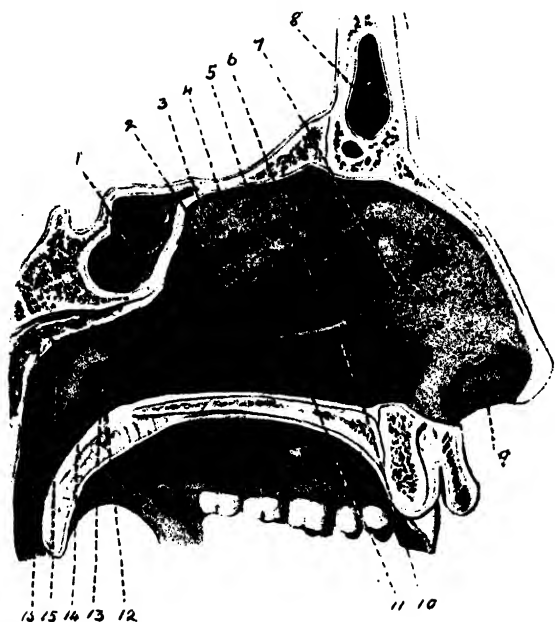


FIG. 11.—THE LATERAL WALL OF THE NASAL FOSSA AND THE NASO-PHARYNX.

- 1, Sphenoidal sinus; 2, superior turbinated bone; 3, superior meatus; 4, middle meatus; 5, middle turbinated bone; 6, middle meatus; 7, atrium of middle meatus; 8, frontal sinus; 9, vestibule of nose; 10, inferior turbinated bone; 11, inferior meatus; 12, pharyngeal orifice of Eustachian tube; 13, levator cushion; 14, Eustachian cartilage forming the Eustachian cushion; 15, lateral recess of the pharynx (fossa of Rosenmüller); 16, pharyngeal tonsil (of Luschka).

the base is free, except above, and forms a prominent and nearly vertical, anterior border to the bone. As a result of this arrangement, the middle meatus, which lies under cover of this turbinal, is perfectly open anteriorly as well as below, hence the ease with which a probe slips into it. The middle turbinal extends quite as far back as the inferior, but

See p. 63.

the latter is continued $\frac{1}{4}$ to $\frac{1}{2}$ inch (6·25 to 12·5 mm.) further forwards, and reaches to within about $\frac{1}{2}$ inch (12·5 mm.) of the nostrils.

The **Middle Meatus** is a groove, about $1\frac{1}{2}$ to $1\frac{3}{4}$ inches (37·5 to 43·75 mm.) long, which lies between the inferior and middle turbinals, and also extends upwards under cover of the latter bone. It is wider in front than behind, and is continued forwards beyond the middle turbinal into a smooth-walled space termed the **atrium of the middle meatus**. This atrium is practically a continuation forwards of the middle meatus without a corresponding prolongation of the middle turbinal. Above and in front the meatus is continued upwards under cover of the turbinal into the **infundibulum**, a bony passage which leads through the anterior part of the ethmoid to the frontal sinus.

On raising the middle turbinated bone there is seen, a little in front of its centre, on the outer wall of the meatus, a large, rounded prominence known as the **ethmoidal bulla**, on which open the middle ethmoidal cells (Fig. 12). This bulla is bounded in front by a deep crescentic groove, the **hiatus semilunaris** (concave, upwards and backwards), which runs into the infundibulum above. In the deepest part of the hiatus, near its middle, and under cover of its overhanging anterior border, the chief opening of the antrum of Highmore is usually found; near it, but higher up, is situated the opening of the anterior ethmoidal cells. The antrum often has a second and much more evident opening lower down and further back, about the middle of the outer wall of the meatus.

The **Inferior Turbinated Bone** (Fig. 11) is longer, narrower, and less prominent, as a rule, than the middle. It is somewhat spindle-shaped, but its lower margin and posterior extremity are often very much enlarged, owing chiefly to a thickening of the mucous membrane which covers them. Not uncommonly the lower margin extends to within a very short distance ($\frac{1}{8}$ to $\frac{1}{4}$ inch—4 to 6 mm.) of the floor of the nasal fossa.

The **Inferior Meatus*** lies below the inferior turbinal. Like the middle, it is of considerable size, and it presents anteriorly,

* See p. 99.

under cover of the inferior turbinal, the lower opening of the nasal duct.

Varieties of the Turbinals.—These may take the form of either hypertrophy or atrophy ; in each case the change may implicate the bones as well as the mucous membrane. .

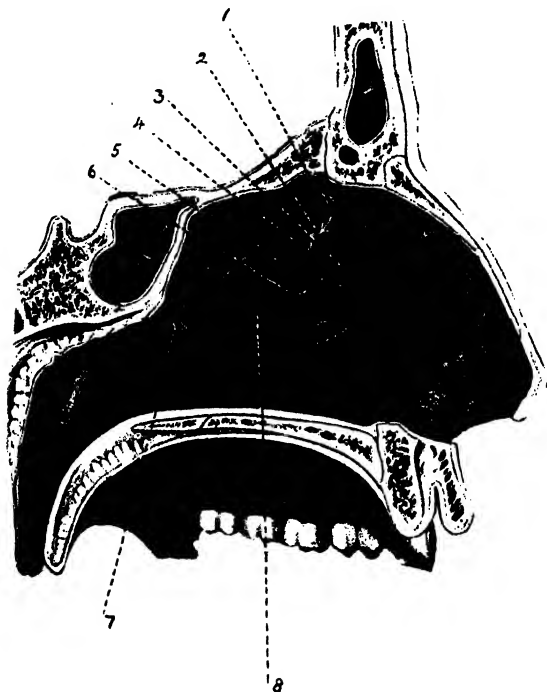


FIG. 12.—LATERAL WALL OF NASAL FOSSA AND OF NASO-PHARYNX AFTER REMOVAL OF THE MIDDLE TURBINATED BONE. (FROM THE SAME SPECIMEN AS FIG. 11.)

- 1, Arrow passed through opening of frontal sinus (infundibulum) ; 2, orifice of anterior ethmoidal cells ; 3, chief opening of antrum of Highmore into hiatus semilunaris, and under cover of its anterior margin ; 4, orifice of middle ethmoidal cells on 5, the bulla ethmoidalis ; 6, hiatus semilunaris ; 7, cut edge of middle turbinate bone which has been removed ; 8, a second opening of antrum, frequently found either here or at posterior part of hiatus semilunaris. (Other parts as in Fig. 11.)

The lower border and posterior extremity of both the middle and inferior turbinals are frequently much enlarged, and this remark applies particularly to the posterior extremity of the inferior turbinal, which is very often the seat of

hypertrophic changes, when it presents a rounded, strawberry-like appearance.

Atrophy of the bones, and to some extent of their mucous covering, is not uncommon. In this state the turbinals are much reduced both in thickness and in width, and look like narrow shelves rather than curved scrolls. When the bones are atrophied, the meatuses are, of course, much wider than normal, and as a result some of the openings which lead into them may come into view.

The **Mucous Membrane** of the nasal cavity is thick and very vascular over the middle and inferior turbinated bones; indeed, over the two ends of both bones and the lower border of the inferior it has the character of erectile tissue. It is also thick over the septum, but is much thinner in the remaining parts. That of the cells and sinuses opening into the cavity is very thin and pale.

A thickening of the mucous membrane of the septum, which may be mistaken for some pathological condition, is often found opposite the anterior part of the middle turbinal. It is known as '*the tubercle of the septum.*'

On the lower and anterior part of the septum, opposite the anterior end of the inferior turbinal, there is a small rounded area (about one-third of an inch in diameter), which, unlike the surrounding parts, is covered by squamous epithelium, and contains a large number of dilated veins. These are the source of the hæmorrhage in most cases of epistaxis.

The **Ethmoidal Cells** are a series of bony cavities which lie in the lateral mass of the ethmoid bone, and open into the nasal fossæ. They are all lined by mucous membrane prolonged from that of the nose. Generally they are divisible into three groups, each group opening by a common orifice, viz., an anterior set, which opens into the upper part of the hiatus semilunaris; a middle set, opening on the ethmoidal bulla; and a posterior, which opens into the superior meatus (Fig. 11).

The **Frontal Sinuses*** are two cavities, separated by a bony septum, which lie between the inner and outer tables of the frontal bones above the root of the nose and the orbits. They are very variable in size, sometimes being quite small, but often extending up in the frontal bone for

* See p. 113.

1½ inches (37·5 mm.), or more, above the supraorbital arch, running out as far as the outer limit of the orbit, and extending back in its roof for 1 inch or further. Very commonly the two sinuses are unsymmetrical, the septum, lying much to one side of the middle line; occasionally, too, the septum is perforated. They are lined by a prolongation of the nasal mucous membrane, and open by the infundibulum into the fore part of the middle meatus (Fig. 11). It is often possible to reach the sinus by directing a probe up along the hiatus semilunaris.

The **Maxillary Sinus**, or **Antrum of Highmore**, is a large cavity, situated in the body of the superior maxilla, which opens into the nasal fossa, and is lined by a prolongation of its mucous membrane. The chief orifice of the antrum is situated in the anterior part of the middle meatus, and about 1¼ inches (31 mm.) above the floor of the nasal fossa; it lies at the deepest part of the hiatus semilunaris, near its centre, and under cover of its overhanging anterior border (Fig. 12). In about 20 per cent. of cases the antrum has a second opening lower down and further back on the outer wall of the middle meatus (Figs. 11 and 12).

The **Sphenoidal Sinuses** are two cavities, separated by a bony septum, and generally unsymmetrical, which lie in the body of the sphenoid bone, and, like the foregoing, are lined by a continuation of the nasal mucous membrane. They open by two more or less circular orifices on the roof of the nasal fossa above and behind the superior meatus. Whilst generally confined to the body of the sphenoid, the cavities not uncommonly extend outwards into the root of the great wings and pterygoid processes, and backwards into the basilar portion of the occipital bone.

Applied Anatomy.

External Ear.—The general direction of the meatus is inwards and slightly forwards, but it is curved in such a manner that its floor and anterior wall are slightly convex (Figs. 1 and 6). Its curves can be nearly obliterated by drawing the pinna backwards and upwards. It measures

1 inch (25 mm.) from the bottom of the concha to the tympanic membrane; if measured from the outer surface of the tragus, this distance is increased to $1\frac{1}{2}$ inches (37 mm.). Its diameter varies, but averages about $\frac{1}{3}$ inch (8.5 mm.); it is narrower near the middle than in the inner portion generally. Foreign bodies often lodge in a little recess between the lower part of the sloping tympanic membrane and the inner end of the floor of the meatus, which latter dips down here rather suddenly (Fig. 1). It should be remembered that pus can readily make its way from a parotid abscess into the meatus through the fissures of Santorini, which are situated in the front of its cartilaginous portion.

In the child the meatus is very much shorter than in the adult, measuring, from the bottom of the concha to the middle of the tympanic membrane, under $\frac{1}{2}$ inch (from 10 to 12 mm.) at birth. The floor and anterior wall are formed chiefly of fibrous tissue, the outer part of which is connected to a prolongation of the cartilage of the pinna, whilst in its inner part is the C-shaped 'tympanic ring' of bone surrounding the membrana below and in front. The tympanic membrane is also very oblique, at birth lying almost in contact with the floor of the meatus. At the same time the tympanic ossicles are as large as in the adult.

Membrana Tympani.—The very oblique position of the membrane—which looks outwards, downwards, and forwards, making an angle of about 45° with both the horizontal and coronal planes—should be remembered. This, with the curvatures of the meatus, explains the difficulty of getting a perfect view of the membrane.

When examined with the speculum (p. 89), the following points can usually be made out, in addition to its obliquity and its funnel-like form: (a) The handle of the malleus is seen extending from above and in front downwards, and slightly backwards to the umbo, or apex of the funnel, which is situated some distance below the centre of the membrane, and corresponds to the tip of the hammer-handle. (b) At the upper end of the handle the short process of the malleus can be distinguished, forming a well-marked elevation on the surface of the membrane. (c) Two ridges run backwards and forwards

respectively from the short process; these are the anterior and posterior *tympanic folds*, often known as *Prussak's striæ*. Taken together, the two folds form a nearly straight line, which is lower in front than behind. (d) The portion of the membrane above these tympanic folds differs from the rest in that it is very loosely stretched, and is consequently known as the *membrana flaccida* (*membrana Shrapnelli*). It corresponds to a notch (incisura Rivini) in the bony rim (sulcus tympanicus) which holds the tympanic membrane, and it is concave towards the meatus. (e) The long process

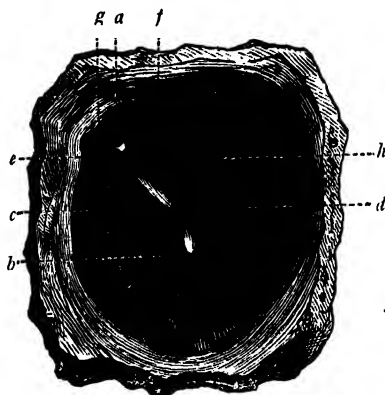


FIG. 13.—EXTERNAL SURFACE OF THE LEFT MEMBRANA TYMPANI SEVERAL TIMES ENLARGED.

a, Short process of the malleus; b, umbo; c, anterior portion, and d, posterior portion of the membrana tympani; e, anterior fold; f, posterior fold of the membrane; g, Shrapnell's membrane; h, long process of incus seen through the membrana tympani. (After Politzer.)

of the incus can often be faintly seen running down behind the hammer-handle, and the chorda tympani nerve can occasionally be made out as it crosses the upper part of the membrane. (f) Finally, when the membrane is examined by reflected light, a brilliant triangular area, known as 'the light reflex,' is seen extending from the umbo downwards and forwards almost to the periphery. It varies somewhat in appearance in different individuals, and in abnormal conditions (inflammation of the membrane, etc.) it may be altogether absent. It is due to the reflection of the light

used for examination from the polished concave surface of the membrane, and the constancy of its position results from the fact that the membrane can be illuminated only from one point, namely, the opening of the meatus.

The whole membrana tympani is divided, for convenience of reference, into four *quadrants* by two lines, one running along the handle of the malleus, the other at right angles to this through the umbo. The sections are anterior superior, posterior superior, anterior inferior, and posterior inferior.

Tympanic Cavity.—Some of the relations of the tympanum are of special importance in connection with the spread of middle-ear disease. Thus, it is separated from the cranial cavity above only by a very thin plate of bone (the tegmen tympani), through which some small bloodvessels pass to the dura mater, thus affording a likely path for the spread of infection from the tympanum to the dura and brain. Its floor is directly related to the bulb of the jugular vein (*i.e.*, the enlargement of this vessel which lies in the jugular foramen), and sometimes the plate of bone separating the two is very thin, or may even be perforated. The same may be said of the layer of bone separating the front of the cavity from the carotid canal, which latter is an immediate relation on this aspect.

Facial Nerve.—The relation of the facial canal (aqueduct of Fallopius) to the tympanum is also of importance. It runs backwards as a curved ridge along the highest part of the inner wall of the tympanum, just above the fenestra ovalis, and then passes down behind that cavity (here lying on the inner or mesial side of the opening of the mastoid antrum) to reach the stylo-mastoid foramen. This foramen lies on the inferior aspect of the skull, and well under cover of the mastoid process in the adult; but in the child, owing to the absence or small size of the process, it practically lies on the outer or lateral aspect of the skull, a short distance below and behind the ear, and here the facial nerve, issuing from it, has been injured when cutting down on the mastoid process.

Prussak's Pouch or Space is important, owing to the fact that it is a common seat of purulent inflammation;

besides, perforations of the membrana flaccida open into it. It is a little pocket formed by folds of mucous membrane, which shut it off completely from the tympanic cavity, except above and behind, where there is usually a small opening. It lies just above the short process of the malleus, and has Shrapnell's membrane for its outer wall. See page 21.

The **Eustachian Tube** leads from the upper and anterior part of the tympanum to the side-wall of the naso-pharynx. Its direction is inwards, forwards (generally more inwards than forwards) and downwards (the latter at an angle of about 30° with the horizontal). Its total length is about $1\frac{1}{2}$ inches, and where narrowest—namely, near its middle—it measures about $\frac{1}{12}$ inch (2 mm.) in diameter.

Its *pharyngeal orifice* (Fig. 11) is a considerable opening, of a somewhat triangular form, with a characteristic funnel-like appearance, due to the presence of a prominent ridge which bounds it above and behind. The opening is situated on the side-wall of the naso-pharynx, immediately above the level of the hard palate, and a short distance ($\frac{1}{3}$ to $\frac{1}{2}$ inch) behind the inferior turbinated bone (see p. 32). The mucous membrane is thick in the cartilaginous portion of the tube, and when congested may easily lead to its complete occlusion.

The Attic.—It should be remembered that the whole of the head of the malleus, and all of the incus except its long process, lie entirely above the level of the tympanic membrane in an upper subdivision of the tympanum known as the attic (or epitympanic recess). It is on the posterior wall of the attic, and not into the tympanum proper, that the mastoid antrum opens.

The Mastoid Cells and Mastoid Antrum.—The *mastoid air-cells* are not present at birth, they are absent also in about 20 per cent. of adult skulls, but in the great majority of adults they are present and well developed, extending through the greater part of the mastoid process, or even beyond it. All the cells open into the *mastoid antrum*. This cavity (Fig. 7), which measures nearly $\frac{1}{2}$ inch from before backwards, and about half this from above downwards or from side to side, is covered in by a part of the squamous portion of the temporal bone, which has grown down behind

the orifice of the meatus. It opens in front and above into the attic by a triangular orifice, along the inner side of which runs the canal for the facial nerve—a fact to be remembered in operations in this neighbourhood. The floor of the antrum is at a lower level than its orifice, thus giving rise to difficulties in the drainage, natural and artificial, of the cavity. The horizontal or external semicircular canal lies in immediate relation to its inner wall, and may be injured in operations on the antrum.

The **Chorda Tympani Nerve** might easily be injured, either by operation or disease, where it crosses the upper part of the tympanic membrane, as a result of which there would be a loss of taste in the corresponding half of the tongue.

Jacobson's Nerve.—The pain in the region of the mastoid process, often felt after operations on the throat (cauterization of the tonsils, etc.), is explained by the fact that the mucous membrane of the tympanum and mastoid cells is supplied by the tympanic branch of the glossopharyngeal nerve, which latter (the glossopharyngeal) also supplies the mucous membrane of the throat.

Tapping the Mastoid Antrum.—In opening the mastoid antrum for suppurative disease of the middle ear, care must be taken to avoid three important structures which lie in close relation to the cavity. These are the lateral sinus, the facial nerve, and the external semicircular canal; to them, perhaps, ought to be added the brain and its membranes.

In practically every case the mastoid antrum can be reached without endangering any of the structures just mentioned by a $\frac{1}{4}$ inch (6 mm.) instrument sent straight in (*i.e.*, without inclination backwards, forwards, upwards, or downwards), at such a point that the hole it makes on the surface shall lie as close as possible to the upper and back part of the orifice of the meatus (Fig. 14). It should not extend more than $\frac{1}{16}$ inch (2 mm.) above a line prolonged horizontally backwards from the upper margin of the meatus; and the instrument must not be driven in more than 16 mm., as the external semicircular canal (which lies on the inner side of the antrum) is, in some cases, not more

than 17 mm. from the outer surface of the bone. As a rule, the antrum will be reached at a depth of 15 mm.

These relations of the antrum may, perhaps, be referred to at greater length with advantage.

The **Lateral Sinus** varies to an extreme degree in both size and position, but the following may be given as its



FIG. 14.—THE LEFT TEMPORAL BONE, SHOWING SOME OF THE CHIEF RELATIONS OF THE MASTOID ANTRUM.

- 1, Level of cranial floor ; 2, situation of mastoid antrum (an instrument sent in here will reach the antrum at a depth of 15 mm. without injuring any of the surrounding structures) ; 3, the lateral sinus, average condition ; 4, course of facial nerve (projected on exterior).

average condition: Beginning near the occipital protuberance, it runs forwards and upwards, close to the superior curved line ; soon, however, it begins to ascend above that line, and continues in an arched course upwards and forwards until it

reaches a point which is usually situated $1\frac{1}{2}$ inches (37 mm.) behind, and $\frac{3}{4}$ inch (19 mm.) above, the *centre* of the bony meatus; here it bends—forming the genu of the sinus—and runs downwards and forwards on the mastoid portion of the temporal bone, lying immediately in front of the line of the posterior border of the mastoid process and of a slight ridge, which prolongs that border upwards. Having reached a point about $\frac{1}{4}$ inch or $\frac{1}{6}$ inch (6 mm. to 4 mm.) below the level of the meatus, it turns in towards the base of the skull. The descending portion of the sinus—sometimes known as the *sigmoid sinus*—in passing down usually lies about $\frac{1}{2}$ inch (12.5 mm.) behind the posterior wall of the auditory meatus. In extreme cases, however, the sinus may reach to within $\frac{1}{6}$ inch (4.5 mm.) of the meatus, and $\frac{1}{12}$ inch (2 mm.) of the outer surface of the mastoid. But even in these cases an instrument introduced in the manner described above will always avoid the sinus.

To Expose the Lateral Sinus.—A $\frac{3}{4}$ inch (19 mm.) trephine-hole, made with the pin of the trephine on a point $1\frac{1}{8}$ inches (28 mm.) behind the centre of the meatus, and on the level of its upper border, will invariably expose the lateral sinus (Fig. 14).

The **Facial Nerve** is in danger of being wounded if the drill, in tapping the antrum, be directed forwards parallel to the meatus. It is also endangered in operations designed to enlarge the orifice of the antrum and to bring that cavity into more thorough communication with the tympanum; for the nerve, as already pointed out, lies in its canal along the inner margin of the orifice of the antrum. Immediately behind the upper portion of the meatus it is placed at an average depth of 18.5 mm. from the surface of the bone; lower down it comes nearer to the surface; for instance, behind the middle of the meatus it will be reached at a depth of 16.75 mm., in each case the measurement being made parallel to the posterior wall of the meatus (Fig. 14).

The nerve can never be injured by a drill or chisel sent *directly inwards*—without inclination backwards or forwards, as described above—at any point on the surface of the mastoid behind the orifice of the meatus; for if the course

of the nerve be projected on the exterior of the bone, it will be found to run entirely in front of the posterior border, and also below the upper edge, of the orifice of the auditory meatus.

The **External Semicircular Canal**, as already described, lies just internal to the inner wall of the antrum, usually at a depth of 18·5 mm. from the surface. Sometimes, however, its depth is reduced to 17 mm., when it may be injured if the instrument, in operations on the antrum, be sent in more than 16 mm. At the same time, it should be pointed out that, with ordinary care, there ought to be no great danger of injuring the canal, as it has a thick covering of white, compact bone at this part, and is consequently easily identified.

As regards injury of the **cranial contents**, the level of the cranial floor in the region of the meatus is variable, and, in a small proportion of cases, if a drill-hole extend up higher than a point $\frac{1}{12}$ inch (2 mm.) above the level of the meatal orifice, it will enter the cranial cavity (Fig. 14).

In Removing the Outer Wall of the Attic with the chisel, the instrument should not be sent in more than 16 mm.—measured through the bony meatus from the surface of the skull—as otherwise the facial nerve or the external semicircular canal may be injured.

The applied anatomy of the naso-pharynx and nose is included in the general account of these parts (see pp. 31 and 33).

CHAPTER III

EXAMINATION OF PATIENT

By H. MACNAUGHTON-JONES

Steps in Diagnosis

IN practice these steps of examination will be found convenient to follow and to note :

History of case, including age, patient's residence, occupation, ear first affected, mode of onset, and duration of deafness.

Ascribed causes :

Hereditary influences or evidences of constitutional taint.

State of the general health.

Past treatment.

Present symptoms, including :

Tinnitus.

Giddiness.

Pain

Discharge.

Tests of hearing with speech, watch, tuning-fork, acoumeter, and Galton's whistle.

Condition of periotic region and auricle.

Condition of external meatus.

Condition of mouth and throat. nasal cavities, and naso-pharynx.

Appearances of membrana tympani.

Results with auscultation-tube and Politzer's inflation.

Results of Examination.

The results of the examination we record as follows :

Cause of deafness.....

Condition of—

<i>Right Ear.</i>	<i>Left Ear.</i>
External ear
Periotic region
Middle ear
Cavity of tympanum
Eustachian tube
Internal ear
Labyrinth
Auditory nerve.....

Following the steps of this table, in making our diagnosis and forming our prognosis, we are assisted to our conclusion (should the case be one of simple deafness or tinnitus for which we are consulted) by the past history given to us. The bearing of the age of the patient on the deafness, the duration of time that it has lasted, and the earliest symptoms of its appearance noticed, are of importance. The fact of one or both ears being simultaneously affected, and whether the tinnitus preceded the deafness, or *vice versa*, are noted. The knowledge of the place of residence, with regard to surroundings, soil, altitude, rainfall, and drainage, may not only throw a light on the obstinacy or recurrence of symptoms, but will assist us materially in our subsequent advice. The occupation of the sufferer may in itself explain the symptoms. Inquiring into the state of health at the time of, or preceding the invasion of, the aural trouble (as, for instance, an attack of fever, influenza, rheumatism, gout, or specific affection, or any possible injury), we elicit the cause to which the symptoms are ascribed. We ascertain whether there be hereditary influences at work on the side of either parent, satisfying ourselves at the same time that there are no objective signs of specific or tubercular taint. Such an investigation will lead us, especially in those cases in which we suspect circulatory disturbances or any organic lesion of the nervous system, to examine the heart and great vessels, applying at the same time some ready tests as to the normal or abnormal state of the nervous system. This latter step is necessary, remembering the relation of deafness and tinnitus to locomotor ataxia and other affections of the spinal cord, as also to the incipient stages of grave cerebral changes. Obviously, such an examination will lead to an inquiry, always of primary importance in cases of tinnitus, into the nature of the renal secretion, which, should it throw a light on the + or - tension of the vessels, may at once be a guide to the cause of the tinnitus.

Before considering the symptoms for which we are at the moment consulted, it is well to ascertain what past treatment the patient may have been subjected to. This will save the useless repetition of therapeutic measures, which it would be

perfectly justifiable to try, but which previous experience has proved to have been of no avail. At the same time, it is more satisfactory that the surgeon should satisfy himself that certain modes of treatment have been effectually carried out, as it is just possible, as in the case of the Eustachian catheter and bougie, that the previous manipulation of these appliances may not have been altogether of an efficient character.

After deafness, the next symptoms which demand our attention are tinnitus, giddiness, pain, and discharge. In a very large proportion of aural cases tinnitus of one kind or another is present, and it is a symptom which frequently is complained of almost as much as, and occasionally more than, the loss of hearing. The mode of analyzing the causes and varieties of tinnitus is entered into elsewhere (chapter on the Internal Ear). Giddiness, as a symptom, occurs generally in connection with tinnitus, and is a prominent one in labyrinthic disease, and forms one of the usual train of symptoms grouped under the name of Ménière. It occurs also in certain affections of the middle ear, in the presence of growths, as a consequence of pressure and stapedia fixation. It is also referred to in discussing affections of the middle and internal ear.

Pain and discharge in the symptomatology of a case we have already discussed.

We now proceed to apply those tests of hearing in the manner already described—namely, speech with whispering, the watch, the tuning-fork, the acoumeter, and Galton's whistle. With these tests alone we are able in a great number of cases to differentiate between middle and internal ear deafness.

The objective examination of the ear now follows. We have first to place our patient in a good position for examination. He should be seated in a chair, with the light used on either the right or left hand side. The surgeon should then sit facing him, and reflect the light by the frontal mirror well on the speculum, in introducing which we should remember the direction of the meatus, and endeavour to straighten it as much as possible by drawing the auricle a little upwards, outwards, and backwards, otherwise there is

a tendency for the light to fall on the wall of the meatus. Opening the mouth, too, will sometimes slightly enlarge the lumen of the canal. Should the patient suffer from some inflammatory affection, acute or chronic, in the external meatus, middle ear, or mastoid region, the area surrounding the auricle has to be carefully inspected and palpated. This is the periotic region. Here, above the auricle, we may have localized subperiosteal swelling or abscess. Below the auricle, otitis externa of any form is commonly associated with a certain amount of swelling, and in deeper-seated mastoid or middle-ear disease tenderness and swelling in this region is an indication of extension of the disease downwards in the neighbourhood of the digastric fossa, or possibly approaching or involving the jugular vein. Behind the ear, redness, tenderness, and swelling are all important signs, indicative of inflammation either extending from the external ear, inflammation or abscess, or mischief either subperiosteal or more deeply-seated in the mastoid itself.

Evidences of past mischief, in the shape of loss of substance in the mastoid, cicatrices, or sinuses, may be present, which will direct inquiry into attacks of inflammation in the past.

Having examined the auricle and the external meatus, noting anything abnormal that may be present in either, and, having removed any cerumen, should such occlude the canal and prevent a view of the membrane, we now inspect the drum-head with the speculum, and note any deviations from the normal appearances that may be present, at the same time that we direct the patient to practise Valsalva, watching closely the effect of the inflation on the membrane. We now take up the auscultation-tube and listen with it, noting the nature of the sound and the degree to which air enters the tympanum. Politzer's bag is next applied, and the inflation is listened to. It is well, then, after the patient has swallowed a few sips of water, to test the hearing with the watch and by speech, and contrast it with the result arrived at before inflation.

We pass next to examine the condition of the mouth and fauces, the throat, including the palate, tonsils and pharynx, and in cases in which exploration of the posterior nares is

indicated, we use the rhinoscopic mirror or palpate the nasopharynx. The anterior nasal fossæ are now looked at with the mirror and speculum, the size and position of the turbinals and septum and any abnormalities being noted. It has always to be remembered by the practitioner that this is a most important step in the examination of every aural case, as in a large proportion the cause of the ear trouble will be found either in some malformation or morbid condition of the nasal structures.

In introducing the speculum, we must remember how timid many patients are on being examined. This nervous sensitiveness is increased when there is any inflammation of the auricle or external meatus; hence it is that a gentle yet firm hand is required to conduct all aural manipulations. In any case of aural affection all force or roughness in manipulation is to be deprecated. Those who cannot manipulate the ear with gentleness had better not manipulate it at all. A man's entire success with a patient will depend much on the gentleness with which he introduces the speculum or the Eustachian catheter; the infliction under any circumstances of unnecessary pain should be avoided. This preliminary encouragement of the patient can only be secured by keeping constantly in mind, and strictly adhering to, the resolution to avoid all force.

Such gentle handling of the ear and encouragement of the patient is especially necessary in children. They are naturally apprehensive and difficult to manage. It is better not to try to do too much with a nervous child at the first visit if it can be avoided. By a little encouragement and tact the fears of the small patient are generally overcome.

CHAPTER IV

ETIOLOGICAL. BRIEF REMARKS ON SOME CAUSES OF DEAFNESS AND AURAL DISEASE GENERALLY

BY H. MACNAUGHTON-JONES

IN many persons deafness comes on insidiously, without any pain, and not until conversational power suffers, either through the obvious difficulty of hearing the voice when spoken to, or that more slowly perceived proof of mischief, the inability to hear general conversation when several people are speaking at the same time, does the patient realize the fact that any impairment of hearing is threatened.

So long as the hearing distance is sufficiently good for the ordinary conversational business or professional necessities, the slight beginnings of deafness pass unheeded and undetected. It is with difficulty that we can at times persuade a patient that the hearing-power is not as good in one or both ears as it might be. Particularly is this the case when we are consulted for tinnitus without any marked deterioration in the hearing. The persistence of the noise is the first warning of the future decadence which follows the early perversion of the function.

Just as we should never neglect occasional or persistent pain in the ear, so should we always be mindful that tinnitus is a warning symptom, not alone of local auditory derangement, but frequently of some more remote mischief in the brain, heart, or general vascular system.

It may be useful here to draw the attention of the student or practitioner to some special causes of affections of the ear, which, however, will be referred to in dealing with the diseases of each part of the organ of hearing in its proper place.

Heredity.—Deafness frequently gives us an example of the law of atavism. It appears to be absent in one generation, and to reappear in the next.

Occasionally, though we cannot find evidence of deafness in either parent, two or three brothers or sisters may be affected. Such hereditary deafness is nearly always of a most unfavourable type. In a great many cases the physician does not see the patient until the deafness is far advanced and there is evidence of serious middle and internal ear trouble.

Obviously, the lesson that we may gather is to attend, in all such families, to any early indication of approaching mischief, and to lessen the chances of it by looking after the throat and tonsils and any nasal obstruction or abnormality which may exist in children; for it is the fact, and a most vital one in regard to this form of deafness, that we frequently find it first make its appearance after puberty, or even later on.

Dentition.—A small proportion of aural affections in children begins during the dentition period. Not only have we reflex excitations of the ear arising from dental sources, but there is the direct association of the inflammatory state of the gums and alveolar structures, while in the enfeeblement of the child's health during the process of dentition there is not infrequently a tendency to otitis with discharge from the ear. In connection with dentition it is important to remember the characteristic signs, as specially drawn attention to by Hutchinson, of hereditary taint in the teeth, in estimating afterwards the distinctions between the mercurial stomatitis, the consequence of mercury administered in infancy, and the dental evidences of hereditary syphilis.

MERCURIAL STOMATITIS.		HEREDITARY SYPHILIS.	
Teeth primarily affected =	First molars.	{	Central upper incisors.
Premolars escape.			
Character of abnormality =	{ Enamel deficient, transverse lines on incisors and canines, dirty, discoloured, and coated with tartar; pitted.	{	Peculiar notch in incisors, dirty, badly formed; often combination of effects seen in deficient enamel and dentine from mercury and syphilis.

Whooping-cough.—The ears are not infrequently affected during severe attacks of whooping-cough. The enfeeblement of the constitution generally, the impoverishment of the blood, the associated naso-pharyngeal catarrhal conditions, and the vascular congestion brought about during violent paroxysms of coughing, with occasional rupture of the membrana tympani, are sufficient to explain this complication.

Diphtheria.—Otitis media is not an uncommon complication in this disease, while deafness may follow the paralysis of the naso-pharyngeal muscular structures after the acute symptoms have subsided. Diphtheritic membranous exudation in the outer ear is extremely rare. The involvement of the organ in an attack of diphtheria is a peculiarly serious complication.

Parotitis (Mumps).—Deafness may come on during an attack of mumps, generally disappearing as the swelling subsides. In other cases suppuration of the middle ear follows. The labyrinth may be implicated and vertigo be present. In other attacks of severe parotitis with associated cellulitis pus may find its way into the tympanic cavity and escape through the external meatus.

Influenza.—Aural complications are very common as sequelæ of influenza. We find as the simplest consequences slight temporary deafness, due to middle-ear obstruction and catarrhal conditions. More frequently, however, there are inflammatory states of the tympanum, resulting in otitis media, with or without perforation of the membrane, and a chronic suppurative catarrh may follow. Sometimes the mischief appears in some form of labyrinthic disturbance, a troublesome tinnitus resulting, or varying degrees of auditory nerve deafness.

Tubercle.—Tuberculous inflammation in children shows itself by suppurative otitis media, with frequent extension to the mastoid process or the petrous portion of the temporal bone.

Bactericidal Causes.—Pathogenic micro-organisms play a most important part in the production of aural affections.

This applies not only to such bacteria as are found in the external meatus, but also those associated with morbid conditions of the naso-pharynx. There are also those micro-organisms which exist in the circulatory current, and which in malarial states provoke inflammatory processes not only in the external and middle, but in the internal ear.

We would first, however, remark upon the suitability of the ear passages for originating and completing fermentative processes. Whether we look to the external meatus, the cavity of the tympanum, or the Eustachian tube, we find those essentials for fermentation, fermentation products, and ferment life which we artificially secure in advancing that process elsewhere or outside the body. We have a limited supply of air and light, with, in the case of the tympanum, only periodical or interrupted interchange. There is an elevation of temperature, due to the free vascular supply in the auditory walls and structures; there is a constant condition of moisture; there is a near approach to 'life without air,' as Pasteur defined fermentation. Look a little further, and we find the ready elements for providing the initial ferments in the ceruminous particles, the sebaceous secretion, the epithelial debris of the external ear, the mucus of the tympanic cavity, and the presence in the Eustachian tube of throat mucus, or nasal and pharyngeal epithelium, that may find its way thither. Also other nasal and gastric gaseous emanations enter periodically into the tube and the middle-ear cavity—for example, those of ozæna.

This fermentative process finds occasional expression in the spreading forms of aspergillus, while in the crevices of the external meatus, the elevations and depressions of the tympanic walls (should it invade the tympanum), or in the ossicular folds, the fungus finds secure shelter and resting-places for its spores to sprout afresh. This being so in the case of fungi and ferments generally, it is not surprising to find such fungi participating in the morbid processes that lead to the chronic purulent discharges of the external or middle ear. Couches of inspissated pus and dead epithelial debris, with hardened mucus, form comfortable beds for the troublesome tenants, who, once in possession, will not stir

without forcible eviction. Though we cannot say that pathogenic bacilli exist in the healthy meatus or its secretions, non-pathogenic varieties do, and in the case of furuncle and abscess pathogenic microbes are found in the outer ear, and may reinoculate adjacent parts. Cornil and Ranvier put forward the hypothesis that in those isolated and recurring contagious inflammations the bacteria, as they cannot live in the blood, are arrested in the lymph vessels of the connective tissue. But in abraded states of the mucous membrane (no matter how slight), whether in the external meatus or the membrana tympani, or in the Eustachian tube, we have the door opened for the entrance of septic and miasmatic bacteria and the establishing of the septic process. Indeed, in catarrhal conditions these bacteria find access to the increased or altered mucus, and through it to the underlying tissues. Imperceptible abrasions are the welcoming portals for aerial and liquid microbes to enter and form purulent deposits in. Löwenberg points out how the fine hairs of the meatus may arrest the microbes, and actually direct them in their course to the congested follicle. The micrococci, both of suppuration and putrefaction, are thus furnished from the outer air to the meatus, from the nose (Löwenberg's micrococcus of ozæna), and from the mouth. Thus we find that the putrescent processes in the external and middle ear so often associated with disease of the mucous membrane and bone are originated by some injury to the external ear, or by a diphtheritic or other ulceration of the mouth, nose, or palate.

The investigations of Moos and Klebs have proved the migration of pathogenic organisms in diphtheria into all parts of the labyrinth, and also into the adjacent portions of the petrous bone. The avenues of entrance may be (according to these authorities) roughly divided thus: (1) The general circulatory current through the thoracic duct and lymphatic vessels, and thus to the Haversian canals and perilymphatic spaces; (2) in other directions by way of the ductus perilymphaticus of the aqueductus cochleæ to the scala vestibuli of the cochlea; (3) the endolymphatic spaces by the lymphatics of the nasal mucosum and the subdural spaces of the nerve

roots and the lymph channels of the peripheral nerves, while others apparently find their way by the fissures (? lymphatic vessels—Schwalbe) in the fibro-periosteal tissue lining the aqueductus vestibuli.

With regard to malarial microbes, it is sufficient for our purpose in regard to the ear to draw attention to the fact that there is a distant connection between malarial conditions and attacks of middle-ear inflammation, the otitis intermittens of Weber Liel. This otologist drew attention to the occurrence of such attacks during the prevalence of or after heavy rains, and at certain seasons of the year, also in swampy grounds and miasmatic districts. He noticed the recurrent nature of the inflammation. What appears to be an epidemic of such aural attacks is thus accounted for by the season of the year, the presence of defective drains and sewerage. Weber Liel remarked in these recurrent outer ear attacks of inflammation the rhythmical nature of the onset of pain, the sense of fulness in the ear, with tinnitus and deafness, followed occasionally by perforation of the drumhead. These symptoms are sometimes ushered in by rigors and perspirations. Aural neuralgia, with general vaso-motor distension, a tendency to exudations, and chronic otitis media, are frequent accompaniments of this form of otitis.

It is obvious what an important part is played in the etiology of aural suppurative discharges by micro-organisms and the value of antiseptic treatment in the management of inflammatory diseases in the external and middle ear, and not in regard to the ear only, but also the naso-pharynx and throat. The dependence of aural furunculi on the presence of a special microbe was first demonstrated by Pasteur, and the unpleasant facility with which auto-inoculation occurs explained. Löwenberg also, with Weber Liel, worked in the same direction, the last-named surgeon pointing out an important clinical feature of recurrent furunculus as compared with ordinary abscess of the meatus. In the former there is more equable swelling of the canal, and not the isolated and globular protrusion or sensitive spot characteristic of abscess. All these facts serve but to accentuate the value of hygienic treatment as an adjunct to other means of treatment, and how

needful it is to bear in mind such hygienic surroundings when dealing with recurrent and chronic inflammatory attacks of both the external and middle ear. We shall refer to the subject again in dealing with affections of the outer ear.

Climate.—Independent of such climatic influences as those just referred to, and in which residence in low-lying districts, the nature of the soil and surroundings, with exposure to certain winds and the frequency of rainfall, are etiological factors to be considered, there are tropical causes of deafness consequent upon chronic congestive, catarrhal, and sclerotic changes in the tympanum. Military life in the British army, in which service in different parts of the world is nearly always demanded of the troops, is a not infrequent exciting cause of deafness. Residence in the various stations in India, bringing in its train malarial fever, rendering the person liable to a recurrence of attacks on return to England, and the effects of such campaigns as those of Ashanti, Abyssinia, the Zulu War, the Afghan, Egyptian, and Soudan expeditions, all necessitating prolonged exposure and fatigue under extremes of temperature, frequently cause throat and ear affections.

In many of these tropical cases we find severe tinnitus, and not infrequently involvement of the labyrinth.

Mental Causes.—The relation of mental worry to aural trouble is clear. This to a great extent depends upon temperament. In some neurasthenic patients we have known overstrain and anxiety followed by a morbid sensitiveness to certain sounds (*hyperæsthesia acustica*); in others there is some form of tinnitus, not infrequently of the pulsating kind. Excess of mental work, combined with anxiety, night-watching and nursing, sudden shocks produced by any cause, are frequent sources of tinnitus, and sudden deafness has been known to follow the news of some financial catastrophe or family bereavement.

Zymotic Causes.—*Typhus and Typhoid Fevers.*—Considerable hospital experience, independent of private cases, enables us to speak with confidence as regards the effects of such fevers as typhus and typhoid in causing deafness and aural disease. This includes the personal conduct of over

2,500 cases of fever of different kinds. The rule is for any temporary deafness which accompanies the fever to pass off when the attack subsides and the patient is convalescent. Permanent lesions of the ear are rare.

This statement does not apply to the aural disturbances which follow malarial fevers. Here the remittent congestive attacks leave permanent lesions and constantly incurable tinnitus or deafness.

The deafness of typhoid fever may arise from affections of the Eustachian tubes and middle ear, acute suppuration being at times set up from labyrinthine trouble or from central nervous disturbance. It is common during the acute stage of the fever, varying with the amount of nervous prostration. It most commonly passes off with convalescence, but in some cases it remains permanent. The deafness of typhus may be due to affections of the Eustachian tube, acute middle-ear inflammation, mischief in the labyrinth or of the auditory nerve.

Scarlet Fever and Measles.—The ravages caused by these diseases in the tympanum will be fully described in the chapter on the Middle Ear.

Small-Pox.—Otitis media, with a serous exudation and pus, may occur during the course of this disease, and pustules have been met with in the cartilaginous portion of the meatus near the orifice (Wendt). As a rule, however, the ear is not affected in this disease. We speak from an individual experience of a large epidemic and the personal care of over 1,600 cases.

Circulatory Disturbances.—In both functional and organic cardiac lesions it is not uncommon to find some form of tinnitus present. In many of these cases a mitral or aortic murmur may indicate the collateral cause of the aural excitation. An anæmic tinnitus, due to deteriorated blood states, is a consequence of the general state of enervation of the tubal and tympanic muscles, bringing in its train alteration in the shape and tension of the drumhead. The dependence of such noises on these causes is shown by their disappearance under improved climatic conditions. When we have such atonic and anæmic states as the consequence of over mental strain the tinnitus is generally more severe, from the combined

causes of vascular disturbance, with irregular blood-supply and innervation of the muscular apparatus. The researches of Politzer and others have shown the effects of leukæmia on the internal ear associated with general leukæmic infiltrations throughout the body, with corresponding degenerations in the tympanum and its ossicles and in the petrous portions of the temporal bones, the labyrinth, especially the cochlea, having neoplastic osseous formations, proliferating connective tissue, and exudation corpuscles, the result of chronic inflammatory processes occurring in the endosteum of the walls of the labyrinth.

Renal Affections and Uræmia.—As a warning symptom in the uræmia of pregnancy, frequently found side by side with retinal disturbances and aberration of vision, tinnitus has a serious import. As in the deafness of nephritis, it is due to the local hyperæmia and increase of vascular tension in the small vessels both of the tympanum and labyrinth. In many such cases the urine is of low specific gravity, and there is an attendant pain in the head. Analogous alterations in the structures and vascular supply of the tympanum or labyrinth, as occur in the retina, may be expected in these cases, localized hyperæmias and infiltrations, sclerotic changes, with thickening contractions and adhesions, minute apoplexies, extravasations or infarctions. Thus, in Bright's disease, with the increase of vascular tension, hæmorrhage may take place into the tympanum, and a hyperæmic condition of the labyrinth, causing both deafness and tinnitus, may result. In other cases the blood is not absorbed, and suppurative otitis ensues.

Drugs.—With a very large experience of the effects of such drugs as quinine and salicine and its compounds, we cannot say that we have known permanent deafness which could, even after a prolonged course of these medicines, be attributed to them alone. Symptoms of auditory disturbance, such as deafness, a buzzing tinnitus, vertigo, are frequently present during the administration of quinine, and are more readily produced in some persons than in others. A reeling and staggering gait, as in the case of labyrinthine vertigo, has been mistaken for drunkenness even to the point of court-

martialing the sufferer. If there be permanent aural complications associated with the administration of quinine, these are more likely to be attributable to co-existing pathological changes than to the quinine, though permanent effects have been attributed by Politzer and others not only to quinine, but to salicylic acid, morphia, and chloroform. There is a general leaning to the view that a hyperæmic rather than an anæmic condition is produced in the tympanum and labyrinth by the quinine. As regards anæsthetics and morphia, our experience does not tend to make us associate any serious aural effects with either the one or the other. (For further remarks on the effect of drugs in causing tinnitus, see chapter on the Internal Ear.)

Miscellaneous Causes.—Intracranial growths involving the auditory centre or nerve, cause deafness, and, dependent upon their situation, are followed by disturbance of equilibration, and, as in the case of *tabes dorsalis*, which affection also is occasionally attended by deafness (Erb and Pomeroy), with associated optic neuritis, atrophy of the auditory nerve, as well as of the optic, occurring in this disease. Deafness has been ascribed to the lumen of the meatus becoming blocked by the throwing backwards of the lower jaw in cases where the teeth are lost.

Naso-Pharyngeal Causes.—In various abnormal states of the naso-pharynx are to be found the most frequent of all causes of affections of the auditory apparatus. In the nose, congenital abnormalities in the septum; vomer, and turbinals; inflammatory conditions, acute and chronic, of the mucous membrane; hypertrophic enlargements of the turbinals, polypi, and occasionally ozæna; in the naso-pharynx, adenoid growths and tonsillar hypertrophic enlargements. There are also those atonic muscular conditions which result from chronic catarrhal states of the pharyngeal mucous membrane generally, including follicular degeneration and relaxation of the palatal muscles, all tending to occlusion, from collapse or otherwise, of the Eustachian tubes. All these and other causes arising in the nose and pharynx are specially referred to in the chapter dealing with such conditions.

Bathing.—This, especially in sea-water, is an important and not unfrequent cause of deafness, the consequence of the passage of water into the tympanic cavity. Occasionally the symptoms are acute, following upon inflammation of the tympanic cavity and also of the meatus. The mastoid may

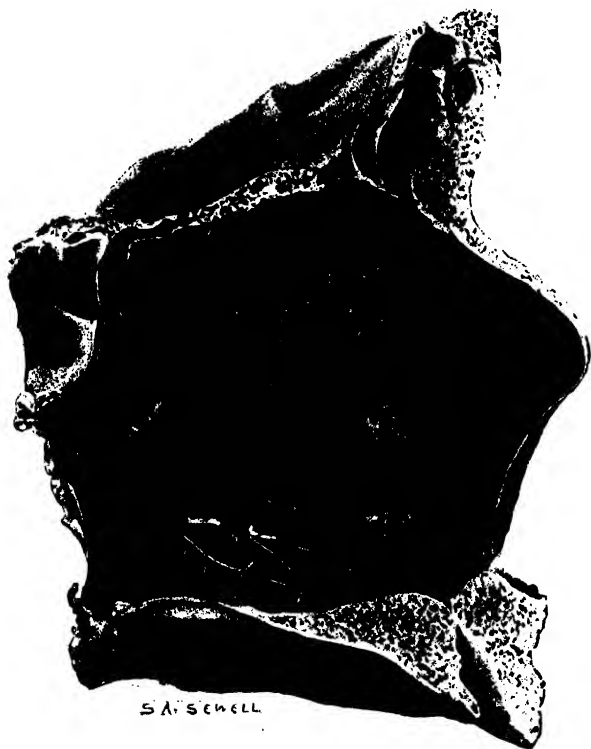


FIG. 15.—SECTION SHOWING HYPERTROPHIC MIDDLE TURBINAL.
PORTION OF SEPTUM LEFT (AUTHOR).

(From subject in the Cecilia Street School, Dublin.)

be involved, and swelling, redness, and pain follow, the pain in some cases being very severe. On the other hand, there may be but little pain, tinnitus and an uncomfortable sensation in the ear being all that is complained of. The accident does not so often occur with expert swimmers as with the young and inexperienced, who, in diving or otherwise, from

the shock or cold, involuntarily fill the mouth and pharynx with sea-water. The middle-ear inflammation may extend to the brain, with most serious results. More frequently we have noticed ill effects follow from the habit of diving on the head. It is well to remember these dangers, especially when a perforation of the membrane or inflammatory and altered states of the tympanic membrane or cavities are present.

Occupation.—Certain callings decidedly predispose to deafness—for example, those of boiler-makers, divers, engine-drivers, gunners, engineers, firemen, and other railway officials. It is not necessary to dwell on the danger of defective hearing in the case of railway servants, a deafness which may not so much be shown by inability to hear ordinary tests at short distances, but to distinguish various sounds, voices, the ringing of a bell, or the dropping of a signal at several feet or yards.



FIG. 16. PERFORATED CELLULOID EAR PROTECTORS (AUTHOR'S).

All such predisposing causes will operate in degree according to the collateral influences present, as, for example, other abnormal conditions of the organs of hearing or general morbid states, or the existence of hereditary deafness. We have noted several cases in which incessant railway journeying caused, or at least induced, a temporary tinnitus. We believe it to be associated with the vibration and noise of the train, the want of proper rest, and the imperfect sleep.

That constant railway travelling does materially affect the auditory mechanism at the time is proved by the well-known fact that certain deaf persons hear well in a railway carriage, while others hear worse. The vibratory movements, noise, and accompanying fatigue must imperceptibly react on those whose hearing is seemingly perfect. Gunnery practice, likewise, may, through the effects of concussion, predispose to deafness.

For those in the Services who are obliged to be present at gun practice sound deadeners are of use. These (Fig. 16)

are made of celluloid in different sizes, and are perforated so as not to encourage a vacuum in the meatus. They act also as protectors when we wish to avoid the use of cotton-wool, saving the patient from the effects of cold and draught. Ward Cousins has also devised a useful 'sound deadener.'



FIG. 17. WARD COUSINS' SOUND DEADENER.

Various other occupations and trades may directly or indirectly lead to inflammatory affections of the ear, either through auto-infection, as in the case of rag-sorters, or as the result of constant exposure to vicissitudes of weather or extremes of climate.

Gout and Rheumatism.—Though the influence of gouty states and the uric acid diathesis generally may occasionally be exaggerated as a cause of morbid conditions of the ear, there can be no doubt that they are potent factors in the etiology of diseases of the external, middle, and internal ear. It may produce its effects at any age, but more frequently these are exhibited in adult and middle life. In the outer ear eczematous inflammation, associated with considerable irritability of the meatus and some slight serous and sticky discharge, with an itching or pricking pain and some swelling and redness in the walls of the canal (Hinton), are characteristic. Occasionally chalk stones are found deposited in the auricle. Exostoses in the meatus are not uncommon. In the middle ear it produces the usual pathological conditions associated with chronic otitis media in the Eustachian tube, the tympanic cavity, and its ossicles; the cretaceous deposits which occur in the membrane are more frequently seen in these gouty cases than in any other. In the internal ear gout is commonly attended by subjective symptoms—

nitus, vertigo, and the other symptoms associated with vertigo (see chapter on Internal Ear). Women, in the later years of life, more particularly suffer from these aural evidences of gout, which with them is often of a latent character.

The twin sister of gout, rheumatism, is also a source of aural trouble, and affects the ear somewhat in the same manner.

Syphilis.—This—acquired syphilis—must be regarded as a special cause of deafness, though not a common one. Primary syphilis of the ear is extremely rare. Secondary cutaneous eruptions, or condylomata of the auricle, are not uncommon. Well-marked cases of secondary syphilitic affections of the middle ear occur, of a chronic and non-suppurative nature. In the majority of the patients, if the relation of the ear affection to its specific source be recognised early, it ultimately yields to sustained constitutional and specific treatment. Internalear mischief, indicated by tinnitus, vertigo, cranial or occipital pain, with deafness, is an occasional accompaniment of the later stages of the specific exanthem. Retinal lesions are sometimes associated with the aural. Hereditary syphilis may affect the ear, and, as in the case of the eye, is, in our experience, more likely to manifest its result approaching and during puberty. The characteristic teeth and corneal, as well as choroidal lesions, are indicative of the source of the aural mischief. The deafness is symmetrical and progressive. The appearance of the drumhead cannot be said to be characteristic, but usually there is an alteration in its form and parts, while the reflexion is lost and the surface has a dull or grayish appearance. Nasal complications are not infrequent; chronic hypertrophic states of the turbinals, from pre-existing rhinitis, with nasal catarrhal discharge, are occasional attendants. Post-nasal catarrh and ozænatous conditions are other complications. Cases are most frequently met with in which the child has never heard well; there has been no history of discharge or complaint of pain. These children, particularly amongst the poorer classes, are not brought in the earlier years of childhood, and we are not often consulted until the growing deafness has become so inconvenient at or about the age of puberty that the parents are forced to take advice.

In infancy and growing childhood hereditary syphilis may show itself in suppurative discharges from the middle ear and perforations of the drumhead, and this cause of otitis media in children has to be kept in mind, any suspicion as to the specific nature of the trouble being confirmed by other evidences of the constitutional change elsewhere. In many

obscure cases, where there is no proof of the parents being tuberculous and no appearance of tubercle in the child, the enquiry must be cautiously but carefully made for a syphilitic origin. More particularly is this necessary in those acute cases which we occasionally meet, when a child or young infant is attacked rapidly with inflammation in the middle ear, followed by profuse otorrhœa, the forerunners of convulsions and death. We have seen general blood-poisoning and collections of pus form in different parts of the body in a case in which the aural attack was ushered in with snuffles, and an abscess appeared over the antrum. The father had contracted syphilis, and the previous children had all died shortly after birth. Such a history should not be overlooked, both for the sake of the patient and surgeon.

Catamenial Disturbances.—Various ocular and auditory affections are consequent upon irregularities in the menstrual function. As we have hyperæmic states of the retina and milder degrees of retinitis, with retinal irritation with parietic conditions of the accommodative apparatus of the eye, resulting from amenorrhœa, so the auditory nervous and vascular structures equally suffer, and analogous consequences follow in the intrinsic muscular (accommodative) apparatus of the ear and irritation of the auditory nerve. Hence at first there is tinnitus, followed in time by a difficulty in differentiating and locating sound, and partial deafness. The anæmia also, which is frequently the cause of the amenorrhœa, produces, through the effects on the vascular tension in the labyrinth, subjective auditory symptoms, noises, pulsations, with a sense of fulness. The palatal muscles are anæmic, and there is an atonic condition of the tubal muscles. In some of these cases there are involuntary spasmodic movements of the palate, and it is in such cases that we find those audible noises in the ear, which are plainly heard with the auscultation-tube. More especially during the menopause we find these retrograde auditory changes beginning. The ear suffers from the same local and intermittent congestive attacks as other organs, while the attendant cerebral disturbances so frequent at this period of life give rise to auditory subjective noises quite apart from any local changes. On many

occasions we have been consulted by patients at the change of life for auditory hallucinations, such as the sound of voices, musical illusions, hearing feet approaching, etc., in whom the hearing was perfect. Sometimes the menorrhagia, or metrorrhagia, which complicates the menopause, as in the case of loss of blood from other causes—for example, in fibroid tumour of the uterus—induces tinnitus.

It is especially during the menopause that we have to guard against the increase of ‘progressive deafness,’ and, if consulted for its premonitory signs, we should attend carefully to the general circulation, the state of the nasopharynx, and the ventilation of the aural passages and tympanic cavities, at the same time that we, so far as we can, control or modify the uterine flux.

Puerperal conditions may lead to tinnitus and deafness. We cannot be astonished at this when we reflect on the changes in the blood and vascular system present during pregnancy, as well as the cardiac hypertrophy or other lesion occasionally attendant upon these hydræmic states on the one hand, or hyperfibrinosis on the other, with or without albuminuria, and which predispose both to hæmorrhage and puerperal septicæmic affections. Here, in the toxic state of the blood and the varying degrees of vascular tension, or, possibly, effusions or hæmorrhage, we have the source, not alone of the retinal, but the accompanying auditory affections, ante- and post-partum.

CHAPTER V

SYMPTOMATOLOGY

By H. MACNAUGHTON-JONES

THERE are four very prominent symptoms, some or all of which are met with in every case of aural affection, that it is well to consider the nature and bearings of. These are pain, deafness, tinnitus, and discharge. Tinnitus and vertigo are fully and separately treated by themselves. Pain, deafness, and discharge we may here consider.

Pain, more or less violent, is present in all acute inflammatory affections of the ear. For instance, it is, as a rule, very acute in ordinary furunculus, in abscess of the meatus, in myringitis, acute perforation of the membrana tympani, and inflammation of the mastoid cells. Under any of these conditions pain may produce a state bordering on delirium, so wild and fierce may it become, especially at night. The constant deep throbbing pain, when mischief has extended to the internal ear, is peculiarly intense and intolerable, while it is most difficult to relieve. It radiates over the side of the head, and is frequently accompanied by frontal ache and great intolerance of light.

In children especially is the occurrence of pain of importance, as it is often the only guide to the malady from which the little ones suffer, the carrying of the hand to the head and to the affected ear drawing the attention of friends and physician to the seat of the mischief some time before the occurrence of the discharge. On the other hand, it is often surprising that so abnormal a condition of things as we find present may exist without the occurrence of pain.

Constantly we see persons with such evidence of long-

standing disease as exostosis of the meatus, polypus, thickening and even perforation of the membrana tympani, sclerotic states of the mucous membrane of the cavity of the tympanum, or ankylosis of the ossicles, all lesions of a chronic character, in which no pain has been complained of, and in which patients deny its existence. Some of the most intractable forms of deafness, with nervine complications, are those in which there has been no pain from first to last. Its presence is of value chiefly in showing the acute nature of the attack, and (excluding causes existing in the meatus) will point to inflammation of the membrane or to mischief in the cavity of the tympanum, the mastoid cells, or in the internal ear. Inflammatory states of the tympanum often cause pain in movements of the jaw in eating. The advent of acute pain in an old-standing case of aural disease, where there is not any manifest cause for its occurrence, should always be looked on with suspicion, the more especially if such be accompanied by any general constitutional symptoms, such as a rigor, vomiting, alterations in the pulse, constipation, or drowsiness. Pain in the ear under any circumstances should, both in old and young, receive immediate attention, and its source be carefully ascertained.

Pain of a neuralgic character is not uncommon. It resembles neuralgia occurring elsewhere in the acuteness of the suffering and the periodicity of the paroxysms. On examination, we may find no cause to explain its presence. At times some slight hyperæmia of the tympanic membrane is present, and there may be tenderness on moving or stretching the auricle, but we have frequently seen violent neuralgia of the ear when no inflammatory condition was coincident with the pain. We have already referred to a form of neuralgia which is due to malarial causes. We constantly meet these neuralgic states in debilitated conditions arising in spring and autumn, when there are frequent atmospheric changes and alternations of temperature. Nor must the possible and even probable cause of the neuralgia in a carious tooth or some neglected dental stump be overlooked.

Earache in patients in whom we can discover no source

of the pain should always insure a careful examination of the teeth. As in the case of retinal affection or other morbid state of the ocular tunics, so in the ear, the tinnitus and interference with hearing may owe their origin to irritation in the dental division of the trigeminus. The aural pain may be purely reflex. The pain associated with mastoid inflammation radiates round the ear, and there is sensitiveness of the mastoid both on pressure and percussion. The pain is still more diffused and less localized when mischief is extending from the attic and threatens the cranial contents. Its situation, whether felt more directly over the mastoid, in the occipital region, or the temporal, may indicate the direction in which we must look for danger. Elsewhere these points are referred to.

Discharge.—The duration of a discharge and the conditions which have preceded its occurrence, the fact of its being coincident with pain or relieving it, its nature, whether purulent or mingled with epithelium, mucus, or blood, its quantity and odour, should be particularly inquired into. One clear rule should always be observed—namely, to regard discharge from the ear as but a sign secondary to a diseased state of some portion of the auditory tract, and one which must be dealt with only after ascertaining its exact source. Nothing can be more mischievous than to regard the mere discharge as the disease, and to remain satisfied with undivided attention to it without arriving at a correct conclusion as to its cause. Frequently polypus, perforation of the membrane, destruction of the ossicles, and inflammation of the mastoid process, are overlooked in the treatment of otorrhœa, from neglect of the simple precaution of examining an ear carefully with the speculum when the discharge has all been removed. As a diagnostic sign, discharge is valuable in directing our attention from the external meatus to the middle ear, the constant source of its presence.

The obstinate character of discharge in the tympanum, especially from the attic, its resistance to treatment, and its tendency to recurrence, have to be remembered in dealing with chronic otitis and in the treatment of all aural conditions in which a suppurative discharge is present. Often when

we cannot see, even with the magnifying speculum, any evidence of discharge, examination with the aural probe and wool will prove the presence of septic material and organisms by the fœtid odour which is thus revealed. *No patient is safe from ulterior consequences as long as there remains the slightest discharge of any kind from the meatus and tympanum.*

Deafness.—We have not the same means of estimating accurately and recording the normal standard of the hearing-power in the healthful ear as in testing the vision of the eye. In people whose hearing is, for all practical purposes, normal, we find a considerable difference in the perceptive power of the ear, both in estimating the degree of loudness of sound, differentiating musical notes, recognising various tones, and in localizing the direction of sound. In making a diagnosis, we have to take account not merely of the hearing of the waves of sound transferred through the air to the auditory apparatus, but also the perception of the sound waves transmitted through the cranial bones by conduction.

In ordinary practice the watch, the tuning-fork, the finger-nail, ordinary speech and whispering, are the familiar means of testing hearing. It is necessary to refer to each of these methods before describing appliances which may not be in the hands of the practitioner, and without which he can arrive at a fair approximate estimation of the hearing distance of the ear under examination.

The Watch.—With regard to the watch, it is imperfect as a test, first, because it cannot enable us to test the hearing-power for more than two, frequently not very distinct, tones; secondly, it does not afford an accurate record of the standard of hearing, save with the tone of the particular watch employed, as all watches vary more or less in the loudness or sharpness of the tick; and, thirdly, from the tendency there is both for adults and children to deceive themselves and us in fancying and asserting they hear the watch if they see or know that it is applied against or held any distance from the ear. It is by no means a good method of testing the conduction of sound through the osseous structures.

We may partly meet some of these objections by using a stop-watch, which places the continuance of the sound under

our control, and conceals from the patient the time of its commencement or cessation.

We have found a stop-chronograph repeater which strikes the quarters with a duplex bell sound most useful, as it allows the examiner to test a child at various distances with the back turned to him, and in the recovery of the hearing enables us to judge correctly of the improvement.

The little patient is attracted by the strokes of the repeater and the chimes. Placing the child at various distances from us, we can direct him to turn quickly round as the watch strikes or chimes ; this he readily does, and we can thus gain a pretty fair estimate of the hearing-power.

By slipping a watch from one hand to the other, and keeping the patient's face turned from us when holding it to the ear, we may easily test his veracity. A round leather pin-cushion can be easily slipped into the hand in its place, and the little patient cannot tell the difference in the feel of its smooth flat surface from that of the watch. Stupid and nervous children do not intentionally deceive, and it is a mistake on the part either of surgeon or friends to threaten or speak to them harshly while testing their hearing. It is necessary to thoroughly occlude one ear, as the tones may not be heard with the ear we are testing, but with the other ; and it is well to repeat the experiment a few times with either ear, beginning close to the ear, and approaching it from a distance. Often the patient can 'follow' the sound when the watch is held at first close to the ear and then is moved gradually away, while, if we commence at some distance and gradually approach the ear, he requires to have the watch brought much closer to catch the tones.

An early test we commonly employ in taking the history of the case is as follows :

If two clocks of different tones be in opposite parts of a room, a large proportion of patients do not hear the two at the same time. Some hear that with the deeper tone, others that with the sharper. Immediately after inflation they will often hear the two distinctly, and this when they have not been aware that there were two in the room. If the attention be drawn to the fact that there are two clocks, some persons will then immediately recognise the two sounds. This difficulty of hearing does not appear to depend so much on the loudness as on the character of the tone, as the louder of the two is not that generally

heard. Those who cannot hear the two ticks at the same time in the first instance are generally the persons to whom table conversation is difficult if many people are talking together.

If the watch be heard equally well with either ear at 100 inches, normal hearing could be estimated at $\frac{100}{100} = 1$. The following method of noting the hearing distance with the watch may be adopted :

H.D.W.	n = 1.
W.	$\frac{1}{100} = \frac{1}{2}$ inch distance.
W.	$\frac{1}{100} = 1$ " "
W.	$\frac{1}{50} = 2$ " " and so on.
W.	$\frac{1}{100} = 0$ not heard.
W.	C = heard on contact with the ear.

Or the result may be simply stated in inches, O standing for not heard, C for hearing in contact, and N for normal hearing.

The Nail.—If the watch be not heard on contact, or barely so, the nail furnishes a useful test in some cases, the distance being noted at which the click of the nail in varying degrees of sharpness is heard.

Speech.—In *speech* we have another important test of hearing. This test may be commenced when the cross-examination of the patient is begun by modulating and altering the tone of the voice when asking questions concerning his previous history and present state. We should also stand some distance behind the patient (to prevent lip reading), and whisper various words or numbers, gradually approaching him, and tell him to repeat them. If one ear must be tested alone, the other should be temporarily closed while going through this performance. This method may be repeated with various modulations of the voice. We find in whispered numbers the most certain test, varying thus: thirty-six—six and twenty—six and forty—sixty-six. The hearing-power of the two ears is thus relatively tested, one ear being carefully occluded by the patient or an assistant while this is being done. If the patient hear better in the presence of noises (*paracusis Willisiana*), or in a railway-train, or not so well at a dinner-table, when many persons are speaking, being unable to follow the general

conversation, this should be recorded. It must also be remembered that the pitch and volume of different persons' voices vary considerably in ordinary conversation, and in the same persons at various times and on different days, dependent on atmospheric conditions, the state of the larynx and the tension of the vocal cords, or the amount of noise present at the time they are conversing. We must recollect that in testing with the watch and by whispering much will depend on the surrounding stillness.

It is as well to ascertain what tones, both as regards *pitch* and *timbre*, are heard best. The differentiation of such sounds being probably regulated by the vibrations of the basilar membrane of the cochlea, any defects in hearing them would most likely point to some mischief in that part of the labyrinth.

Double hearing, when two sounds are heard although only one stimulus is given, and exaggerated and painful hearing (*hyperæsthesia acustica*), from the acuteness with which the sound is heard, are sometimes complained of.

There is a certain set of symptoms, some of which are almost invariably met with in every case where we have ankylosis, adhesions, or rigidity of the membrane lining the cavity of the tympanum. A lucid description of the typical symptoms which are complained of by the great majority of patients who have adhesions of the membrana tympani and ankylosis of the ossicles was given by Toynbee.

Summarized, the symptoms are as follows: Incapacity to hear when two or more persons are speaking, want of discrimination of words, and inability to follow rapid conversation. There is also the need for fixing the attention by a distinct effort of the will in order to catch what a speaker says, failure to do so being the result of relaxation of the effort; hence a sense of fatigue when listening to conversation. In the same patients hearing is improved when travelling in a carriage or in a railway-train, a result which Toynbee attributed to the vibratory movement thus communicated to the chain of ossicles, bringing them under the action of the intratympanic muscles, and restoring their respective functions in adjusting labyrinthine pressure. In these cases

both the adapting and discriminating power of the ear are interfered with. Stapedial ankylosis is the condition most likely to be followed by such symptoms.

Trötsch thought that in the case of persons hearing better during noises, distinct vibrations brought the stapes and incus closer together through the inward pressure of the membrana tympani, and thus prevented the interruption to the conduction of sound caused by the abnormal separation of these bones. Toynbee's view, that adhesive inflammation had produced ankyloses, and that the symptom was pathognomonic of this affection and incurable, is that taken also by Politzer.

The facility with which certain persons follow conversation by watching the lip movements of the speaker has to be remembered. This is especially noticeable in the case of children and young persons who have become deaf after they have learned a number of words and the alphabet.

In testing these young patients for the possession of hearing-power, they must not be allowed to see the source of the noise, and it is better to blindfold them during examination. It will be found that many will hear the tuning-fork when placed on the head or over the mastoid who do not hear such sounds as the piano, a whistle, or other loud noise. In these cases the inference is that there is a certain degree of perceptive power retained in the auditory nerve.

The Acoumeter.—Poltzer's acoumeter may be employed as an accessory test of the hearing. It consists of a horizontal steel cylinder tightly fitted by a screw to a perpendicular vulcanite pillar, while a lever percussion-hammer is so arranged in the vulcanite pillar that by pressure on the short arm of the lever the hammer is made to fall on the steel cylinder and produce the tone. The acoumeter is also furnished with a metal plate, which can be used to test sound conductions through the cranial bones by pressing it over such bones as the temporal or mastoid, and on the external meatus. For this latter purpose the acoumeter will be found most useful. The distance at which the tone produced by the lever hammer is heard is estimated by a metre scale. For the reason before stated in the case of the watch, the hearing distance is measured by gradually bringing the acoumeter nearer the ear tested, the patient's back being turned to the observer until the tone is heard, so that the patient cannot see the instrument or know the direction of the sound. As it is a fact that our accurate judgment of the direction of

sound is dependent on hearing with both ears (which fact can be proved experimentally in persons whose hearing is normal, and is the result of the education of the aural synchronously with the ocular sense), it happens that when the hearing is not assisted by vision, and still further when, either through interference with the transmission of sound in the external meatus or its conduction by disease in the middle ear, the binaural hearing is interfered with, this judgment of direction is either lessened or lost. This error of hearing may be of considerable moment in the case of railway officials or sportsmen and those engaged in military service.

Fifteen metres was the distance fixed by Hartmann and Politzer as the average normal distance of hearing for the

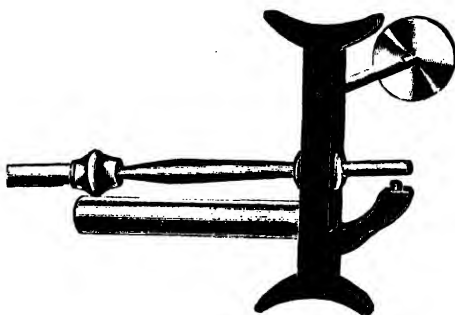


FIG. 18.—THE ACOUMETER.

acoumeter. It has the advantages of (1) uniformity and intensity of tone ; (2) a greater correspondence to the voice and whispered speech than the watch ; (3) its simplicity and size.

The researches of Oscar Wolf proved that the pitch of the fundamental note varies in the pronunciation of the different vowels, and, further, that this difference exists in a greater degree between the vowels and consonants, the latter being heard much less distinctly.

Politzer has shown experimentally that :

‘ If words be spoken into the meatus through a speaking trumpet, the ossicula exhibit as many vibrations as there are syllables in the word, and that the greatest excursion of the vibration corresponds with the vowel of the syllable.’

Taking a few of Oscar Wolf's conclusions regarding the relative distances in metres at which the sounds of certain vowels and consonants can be heard, we have these facts well exemplified :

A = 252 (pronounced as in hart), O = 245, E = 231 (as in end), I = 238 (as in ci), l = 210 (as in inch), U = 196 (as in hunt), S = 123·5, K = 44·1, B = 12·6 (as in before), H (aspirate) = 8·4.

He divides the voice-sounds into (1) the deep, like R and V ; (2) the middle, like B K T (explosives); (3) the high and strong, as S Sh and G ; (4) the high and weak, as F L N H.

Galton's Whistle.—Galton's whistle is most valuable in differentiating the seat of an aural lesion as between the



FIG. 19.—GALTON'S WHISTLE.

internal ear and auditory nerve and the conducting media—that is, between the sound-perceiving and the sound-conducting apparatus. The normal ear perceives from 16 to 32,500 vibrations to the second as musical notes if these be regularly repeated. These are looked on as the lower



FIG. 20.—PROFESSOR EDELMANN'S (MUNICH) NEW 'GALTON-PFEIFFE' (MODIFIED GALTON), THE ACCURACY OF WHICH IS TESTED AND ESTIMATED BY KUNDT'S DUST FIGURES.*

and upper limits of audition. Galton's whistle is of use in enabling us to ascertain rapidly the extent to which the upper limit is deteriorated. The range of perceptive power is influenced in the normal ear to a certain extent by age, the greatest appearing to be between the years of twenty and thirty, decreasing somewhat in the advanced periods

* See appendix for the method of producing Kundt's figures and a full description of the Galton-Pfeiffe.

of life. This is due not merely to senile thickening of the membrana tympani, but also to alterations in the tympanum, reduction of conducting power in the ossicles, and diminished sensibility of the auditory nerve. It may be worked either by the mouth through a tube which is attached to it, or by a rubber bulb, and the number of vibrations are shown by the scale upon the tube, which fits into the revolving collar, the note being raised or lowered at each revolution of the barrel. We can thus readily arrive at the relative perceptivity for high tones of the two ears.

Turnbull, several years since, experimented with König's rods. 'They were made of choice white tempered steel. These are held suspended by a silk thread, either close to the ear or at a definite distance—say 35 feet—from the patient, and then tapped on the end with a little steel hammer, which causes a clear, ringing over-tone like a bell. They are 2 centimetres in diameter, and from $2\frac{1}{2}$ to 10 centimetres in length, so that they regularly increase from 20,000 to 60,000 vibrations in the second, according to their size.' They were held within 2 inches of the ear; their temperature was about 70° F. The observations were made in a room remote from noise and during cloudy weather. With these rods he could accurately test the perception of the finest musical tones. From the table he has published the average capacity of the normal ear for high tones between the years of twenty and thirty would appear to range from 40,000 to 60,000. It has since been confirmed by the use of Kundt's dust tubes that some persons can hear tones of 50,000 to 60,000 vibrations.

Zwaardemaker has arrived at the following conclusions as to the upper tone-limit at different periods of life :

	Under 10 years at the mark	...	1'22.
Galton's whistle heard	From 20 to 30 " "	...	1'39.
	From 40 to 50 " "	...	2'23.
	Over 60 " "	...	3'03.

It must be remembered (Melde) that the perception of high notes depends on the strength of the tone.

The Tuning-Fork.—The aural tuning-fork (Fig. 22) is larger and heavier than the ordinary one, and has shifting clamps on the prongs, held in place by screws, to alter the tones. The higher up the clamp is fixed on the prong, the deeper is the tone, and, according to Kiesselbach, the weight of the clamp alone deepens the tones. In practice two

ordinary C and C¹¹ tuning-forks, with a wooden button on the ends to place on the forehead, and pieces of indiarubber tubing slipped over the prong to alter the tones, as recommended by Bing, will answer every purpose.

To make an exhaustive and accurate diagnosis of the relative power of the bone conduction and air conduction of vibrations, we must resort to the Hartmann series of five forks (C = 128, C^I = 256, C^{II} = 512,



FIG. 21.—RUBBER PERCUSSOR FOR STRIKING THE LARGER TUNING-FORKS.

C^{III} = 1,024, C^{IV} = 2,048), with such a series comparing the results in the normal and the affected ear; or, in a case where both ears are subject to different degrees of deafness, we can arrive exactly at the lower and higher tone-limits, supplementing the tuning-fork test with that of Galton's whistle.

The cardinal physiological fact which forms the starting-point for testing the hearing with the tuning-fork is that, when a vibrating fork

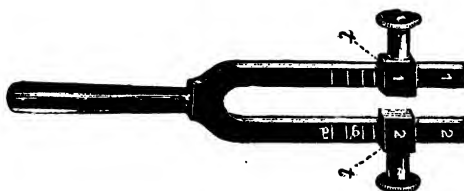


FIG. 22.—TUNING-FORKS.

is placed on the middle line of the vertex, both ears being in a normal state, the sound is heard equally in both. If the external meatus of either side be closed with the finger, the sound appears to be transmitted to, and intensified in, the occluded ear. This simple experiment, which is clinically repeated if there be obstruction in the outer ear—as, for

example, from cerumen, a foreign body, or polypus—leads to the conclusion that if, on placing the tuning-fork on the head, it be heard best in the affected ear, the defect is in the sound-conducting media. This is true whether it be in the external meatus or the middle ear. For instance, an accumulation of mucus in the tympanic cavity will produce a similar effect. We have several times proved that though this is a general rule, it is not an absolute one. There are persons whose hearing is very acute, and in whom there are no signs of any abnormal conditions, who do not hear the tuning-fork louder on closure of the meatus.

Nothing in the examination of an ear requires the exercise of so much patience as the trial with the tuning-fork. Each experiment should be repeated several times, and the patient kept in ignorance of the result expected.

Deaf patients, especially the poorer ones, are often intensely stupid. To arrive at a correct conclusion, we must try their accuracy several times. It is a good plan to return to a previous step in the examination, and to repeat the question as to the intensity of the sound. Constantly patients will at the same examination contradict assertions which a minute before they have made with the greatest confidence, and it is often a great trial of patience to elicit the truth. The following are the steps of testing with the fork, whether the deafness be unilateral or bilateral, and of locating the portion of the ear in which the lesion exists, as also its nature :

TESTS.

1. Ascertain if the sound of the fork be heard louder in either ear, the meatus of each remaining open.

2. Whether the sound be heard louder in either ear, or the contrary, the meatus of each having been closed alternately with the finger (Weber). Close the meatus of either ear with the finger, and allow the sound of the fork placed on the vertex to die away, and then remove the finger from the meatus and ascertain if the sound be again heard (Bing), and note the duration of the interval.

3. If the sound as heard with the meatus of each ear closed be louder as contrasted with its intensity when both ears are open. This may be done by making the patient with his thumbs quickly close the ears on placing the fork on his head, and by testing him alternately with both the ears open and closed.

4. If the sound of the fork be heard when it is held opposite the meatus after it has ceased to be heard on the mastoid of that ear, or, on the contrary, if it be not so heard (Rinne).

5. Let the sound of the fork, placed on the middle line of the patient's head (for high or low tones), die away; let it be transferred quickly to the observer's head or that of a bystander with normal hearing; find if it be still heard, and take the duration of time in seconds that elapses before the sound is lost. Repeat the same process on the mastoid.

6. With the C' or C¹¹ and C¹¹¹ forks test perception of the high and low tones both as regards intensity and duration.

7. Place a tuning-fork on the vertex, compress by pressure the air in the meatus, and ascertain if the sound be lessened, to again increase on removal of the pressure (Gellé).

8. After the tuning-fork held before the ear has ceased to be heard, the end of the finger should be inserted into the ear, and the vibrating-fork placed on the finger, when the sound again becomes audible and is heard for some time (Gruber).

Let us take a few uncomplicated examples. Having by the speculum excluded any cause which can exist in the external meatus, such as cerumen, polypus, epidermis, or foreign body, we wish to arrive at a conclusion as to whether the deafness and tinnitus be due to tympanic obstruction or to disease in the labyrinth and of the auditory nerve.

First, a patient hears *badly in the right ear* and well in the left. With the tuning-fork on the head in the first step of the examination, he hears *it loudest in the right ear*. The presumption is that the cause is in *the cavity of the tympanum on that side*. On closing the left ear, the sound is intensified in it, equalling, if not exceeding, that heard on the right. On now closing the right ear, the sound is not as a rule increased. The diagnosis that it is due to obstruction or to middle-ear disease is thus confirmed in a majority of cases.

A patient is *deaf in both ears*; the tuning-fork placed on the head *is heard well and equally in both*, and there is *no difference, or very slight, on closure of either meatus*. We may presume middle-ear mischief in both ears.

A patient is *deaf in the right ear*; the tuning-fork placed on his head *is heard louder in the left ear*. We assume *nerve deafness (perceptive apparatus) of the right ear*. On closing the left ear, the sound is *intensified in it*; on closing the right, *there is no difference, or the sound is decreased*. We strengthen our assumption of nerve deafness in the right ear.

A patient is *deaf in both ears*; the tuning-fork placed on the head, *he hears perhaps badly, and the sound dies rapidly away*. This can be ascertained by testing him as usual, and transferring the fork quickly to the observer's head or teeth on the patient's making a signal that the sound has disappeared. Repeat this test over the mastoid. It is possible *he may not hear the tuning-fork* when placed on the head, and we must transfer it to the teeth before the vibrations are conveyed. Closure of either ear produces little difference, or if anything the sound is lessened. We diagnose *internal ear (perceptive apparatus) and auditory nerve deafness of both ears*.

As to the patient hearing the sound less distinctly on closing the deaf ear (Roosa) in a case of uncomplicated nervine deafness, or its being slightly intensified (Hinton), we believe that the result is variable.

Complications may exist which escape observation, and which are outside our power of diagnosis. Such complications in the tympanum, and involving its membrane and ossicles, would influence the result. They co-exist frequently with nerve deafness, and hence much of the difficulty lies in this source of error.

Though the above tests are generally found to lead to a correct conclusion, anomalous cases, and in the instance of very intelligent persons, are constantly occurring in a large aural practice, which we do not pretend to account for, and which are more or less at variance with them.

In such cases the mischief is not confined to the cavity of the tympanum and the ossicles, but chronic inflammatory states of the lining membranes, adhesion, and partial ankylosis of the bones have been produced, implicating the labyrinth and nerve. Here we find the membrane unyielding on inflation, and no improvement in suction with the pneumatic speculum. Its concave and thickened appearance verifies the diagnosis. It must also be remembered that the conductive power of the bones in some people is very much impaired. This is more especially the case in the old.

Tests 4 and 5 enable us to arrive at the value relatively of air and bone conduction in the ear tested. If the air conduction exceed the bone conduction, we note (R +), and the test is positive; *vice versa* we register (R -), and the test is negative. Here the conducting apparatus of the middle ear is at fault. Gellé's test (No. 7) is employed to test the degree of mobility in the ossicular chain after compression of the external auditory canal, compression in the case of normal conduction lessening the sound, which is again restored when the compression is released.

Limitation of Hearing.—Alexander Ogston has drawn attention to the limitation of hearing of the normal ear in lateral directions. This was shown by placing a watch in the meatus line, first horizontally, and then either moving it backwards or forwards, or by making the patient rotate his head, the extent of the rotation or movement of the watch being marked in degrees, and the angles measured from the horizontal plane of the meatus line, as shown in the annexed diagram, in which the decrease in the hearing distance is shown by the number of feet, with the corresponding degrees of deviation forwards or backwards. He found the greatest point of acuteness 15° in front of the meatus line.

When the hearing in the vertical plane was next examined, it was found that here also the sound was not best heard when opposite the meatus. It was there audible at 10 feet, while at 15° above, the range diminished to 8 feet, 40° above

to 6 feet, and 60° above to 3 feet and less; but below it slowly increased for 35° , at which point it reached 12 feet, diminishing then to 10 feet at 40° , and to 3 feet and less at 50° , as shown in the diagram (Fig. 24). The point of most distinct hearing is therefore below the ear.

Ogston has also described a symptom associated with lesions in the labyrinth, to which he gave the name of touch deafness. It is associated with other evidences of labyrinthine involve-

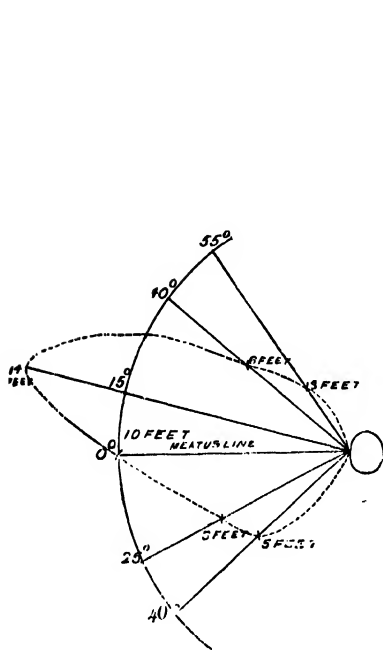


FIG. 23.—HEARING IN THE HORIZONTAL PLANE.

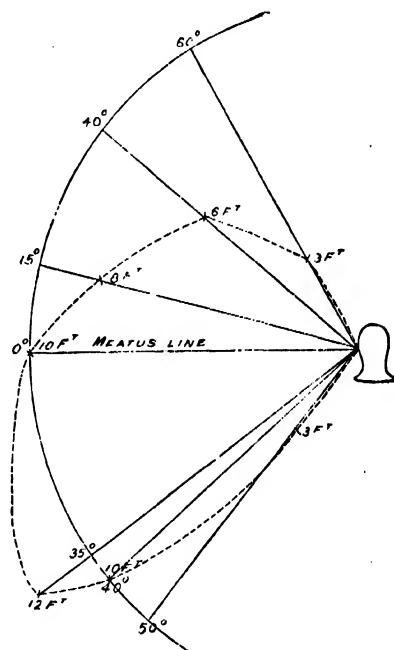


FIG. 24.—HEARING IN THE VERTICAL PLANE.

ment, such as tinnitus and giddiness, with diminution of the perception of the higher tones. He thus describes the condition :

‘ This deafness gives rise to a singular phenomenon in the region of the external auditory meatus. When, in a normal ear, the finger is brought into contact with the skin around the meatus, the individual both feels and hears the contact. If the deafness described is present, the contact of the finger

is *felt* as usual, but is not so distinctly *heard*, and hence for three-quarters of an inch in front of and below the meatus, and over nearly the whole pinna, when the finger is rubbed gently so as to stir the fine hairs and the skin, the patient feels as if the part touched were benumbed (Fig. 25, where the benumbed area is shown), in marked contrast to the sound ear, where the usual familiar sensation is perceived.

‘The numbness described is not a symptom peculiar to disease of the labyrinth, as anything that interferes with the

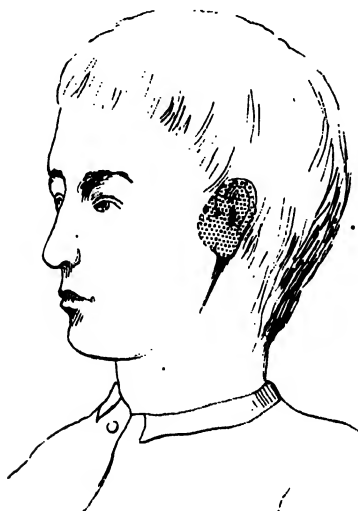


FIG. 25.—AREA OF TOUCH DEAFNESS IN EFFUSION INTO THE LABYRINTH.

conduction of sound to the internal ear will equally produce it. It can be caused by plugging the external auditory meatus pretty firmly with cotton-wool, and it may also exist where unusually large collections of cerumen block it up. It will not be well made out, however, in any condition unless the interference with hearing be considerable, and hence it is slightly marked or absent during the milder attacks of effusion into the labyrinth, and also in the severer attacks when the great degree of deafness accompanying their earlier stages is passing away.’

CHAPTER VI

SOME APPLIANCES, DIAGNOSTIC AND THERAPEUTIC

By H. MACNAUGHTON-JONES

SUNLIGHT is undoubtedly the best light when obtainable, for a beautiful view of the membrane can be had by its means; but the light should be thrown rather on the wall of the meatus than directly on the membrane, as by its intensity it may dazzle and prevent us seeing distinctly.

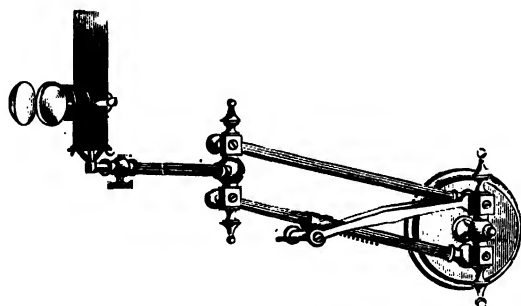


FIG. 26.—GAS LAMP BRACKET AND CHIMNEY FOR ARGAND BURNER.

Can also be adjusted for an incandescent burner, the electric light, or oxyhydrogen gas. The oxygen may be kept in a bottle at the side, standing on a tripod, or the lens and burner may be fixed directly over the oxygen bottle.

Unfortunately, as sunlight is not to be depended upon, artificial light must be used. We may employ coal gas, oxyhydrogen gas, electricity, or oil.

For work in the country, a movable standard lamp for either gas or oil is convenient.

A forehead mirror, with elastic band or on spectacle frame, with a focal length of about 8 inches, is necessary. We prefer that kind shown in Fig. 30.

Aural specula are made of different shapes and of various materials. We prefer the silver specula, and three or four sizes of the shape depicted, as we consider it affords the best illumination, and is easily kept clean and bright. Some like the old funnel shape of Gruber, and for children the expand-



FIG. 27.—ELECTRIC LAMP FOR GRIDIRON BURNER (FIFTY CANDLE) ON SLIDING-ROD WHICH CAN BE ROTATED OR RAISED AND LOWERED AT WILL.

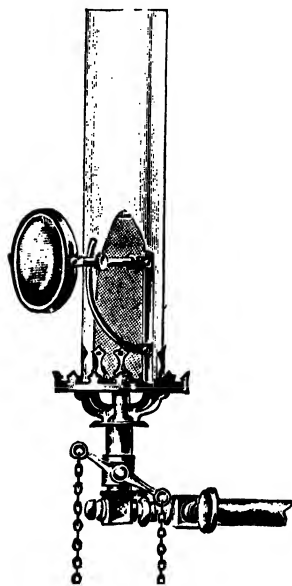


FIG. 28. —INCANDESCENT LAMP WITH ADJUSTABLE BULL'S-EYE ON MOVABLE BRACKET.

ing speculum of Kramer. The magnifying speculum we originally devised affords a ready means of obtaining a magnified view of every portion of the drumhead. It is made in three sizes. The clip which holds the lenses (from twelve to sixteen dioptrics) is attached to the rim of the speculum by a ball and socket joint. With a little practice in manipulating the light, which in this case is best done

with a hand-mirror, any deviation from the normal surface of the membrane is apparent, as well as a good view of Shrapnell's membrane. With the assistance of Valsalva's

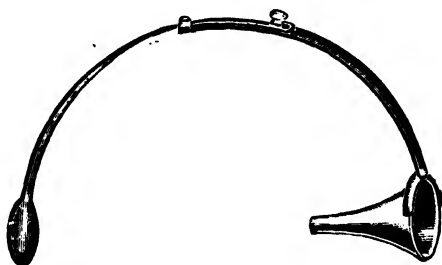


FIG. 29.—SELF-RETAINING CLIP AND HEAD-SPRING FOR KEEPING THE SPECULUM IN POSITION (ANY SIZED CLIP CAN BE USED).



FIG. 30.—REFLECTING MIRROR (MIRRORS OF DIFFERENT FOCAL LENGTHS CAN BE ATTACHED TO THE HEAD-SPRING).

method, adhesions can be detected and the smallest perforation seen.

A nasal speculum is necessary for examination in every aural case; also a rhinoscopic mirror for inspecting the posterior nares and the naso-pharyngeal space. Perhaps

for ordinary use that of Duplay is the most convenient and affords the best view. For the posterior nares an ordinary



FIG. 31.—MACNAUGHTON-JONES'S ORIGINAL MAGNIFYING SPECULUM.

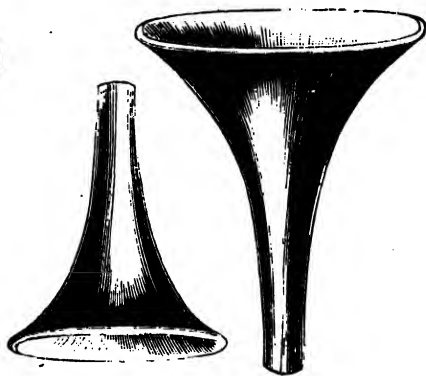


FIG. 32.—AURAL SPECULA.

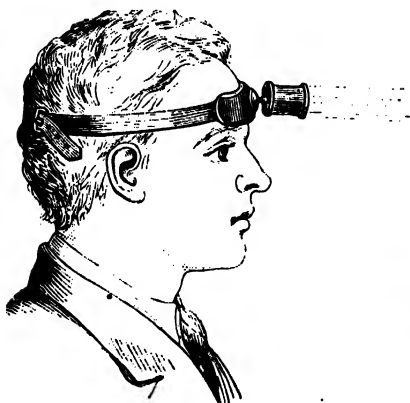


FIG. 33.—ELECTRIC PHOTOPHORE ON FOREHEAD.



FIG. 34.—NASAL SPECULUM (DUPLAY).

small sized laryngeal mirror, set at a proper angle, is convenient; but the mirror, of Zaufal, the angle of

which can be regulated by the thumb on the lever, is the best.

Siegle's Pneumatic Speculum.—For determining the presence of adhesions of the membrane and the mobility of the malleus, the pneumatic speculum first introduced by Siegle is very valuable. It consists (Fig. 37) of an ordinary

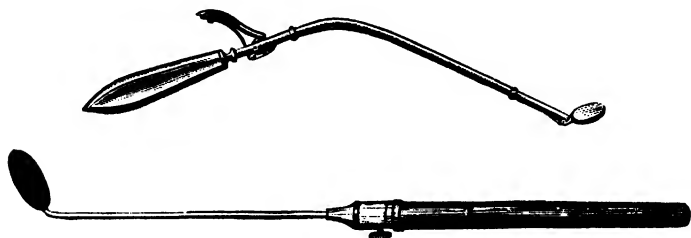


FIG. 35.—RHINOSCOPIC MIRRORS.

vulcanite speculum, which screws into a vulcanite box, covered with a glass lens, which is also screwed on. By placing a little piece of indiarubber tubing on the tubular part, it fits air-tight into the meatus. The box has an india-rubber exhausting-tube, with a bag attached for condensing or rarefying the air in the meatus, and thus acting on

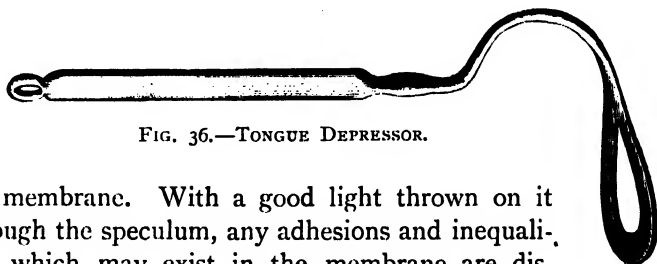


FIG. 36.—TONGUE DEPRESSOR.

the membrane. With a good light thrown on it through the speculum, any adhesions and inequalities which may exist in the membrane are disclosed. It is also of use for therapeutic purposes in cases of middle-ear deafness (*vide* chapter on the Middle Ear).

The **auscultation-tube**, or **otophone** (frequently, though inaccurately, called the 'otoscope'). This instrument (Fig. 39) consists of a simple indiarubber tube, from 2 to 3 feet long, having a bone ear-piece at one end, and a vulcanite one at

the other ; thus the surgeon can always use the same ear-piece for examination. Three tubes may be had connected to a central hollow vulcanite ball. This form is useful for teaching purposes, as a student can examine the ear at the same time as the surgeon. If the surgeon place a tube in either ear, the intensity with which the sound is conveyed is increased, and the least inflation perceived. Double German

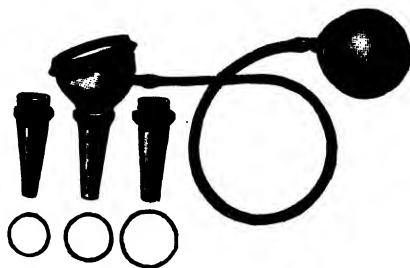


FIG. 37.—SIEGLE'S SPECULUM.

otophones, on the principle of the double stethoscope, are made.

The auscultation-tube is necessary for ascertaining the results of inflation, either by the Valsalvan or Politzer's method or by the Eustachian catheter. On inflation by any of these methods, with the auscultation-tube in position—that is to say, one end in the patient's ear and the other in the surgeon's—various sounds are heard. If the Eustachian



FIG. 38.—FINE SOFT SILVER PROBE FOR EXPLORATION OF THE MEATUS AND TYMPANUM.

tube and cavity of the tympanum be in a normal condition and free from obstruction, a full clear note is heard as the air strikes the drumhead. If there be a certain amount of obstruction, a more or less feeble and distant sound is heard. A peculiar moist, at times gurgling, sound, varying in intensity, is heard if there be an accumulation of mucus or fluid in the tympanic cavity. On the other hand, there is

in many cases of old tympanic mischief a dry crackling sound; it accompanies flaccidity of the membrane; and is heard in long-standing cases of retained secretion. Should a perforation of the drumhead be present, a whistling sound, more or less distinct, is heard.

The mode of using Valsalva's method of inflation is simple: The patient is desired to shut his mouth, and at the same time to hold his nose firmly, and then to blow (not too forcibly), when, if there be no obstruction, the air is at once

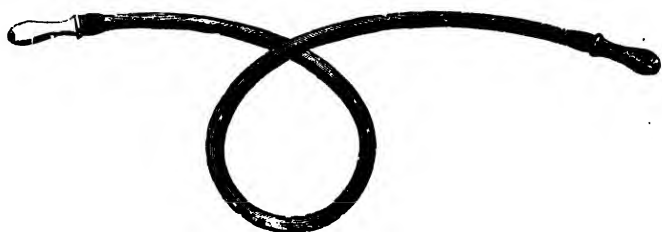


FIG. 39.—AUSCULTATION-TUBE.

heard by the listener with the auscultation-tube impinging against the membrane. By reversing this method—that is to say, swallowing whilst the nose and mouth are closed—the tympanum may be emptied.

Politzer's Balloon.—The original bag of Politzer is an ordinary 6-ounce indiarubber bottle with an inlet valve



FIG. 40.—POLITZER'S BALLOON FOR INSUFFLATION.

(Fig. 40). The nozzle of the bag should be covered with a piece of rubber tubing, or it may be had with the longer tube and olive-shaped nose-piece of Weber-Liel. This, however, is not as convenient for the surgeon's use as the short straight nozzle covered

with rubber. A hard rubber nozzle, conical in shape,* is useful to the novice, as it cannot possibly be forced into

the nostril and damage the nasal mucous membrane. The following is the method of using the bag or balloon: The patient is given a little water to hold in his mouth, and he is made to incline his head slightly to one side. In the floor of the nostril corresponding to the ear it may be our wish more forcibly to inflate, we introduce the tube or nozzle in a horizontal direction. The head is inclined from the same side, the nostril being upturned. If both ears are equally affected, it is better alternately to inflate through either nostril. The surgeon now firmly closes the nostrils with the thumb and index-finger of the disengaged hand, at the same time that he retains in position the nozzle



FIG. 41.—CONICAL RUBBER NOZZLE.

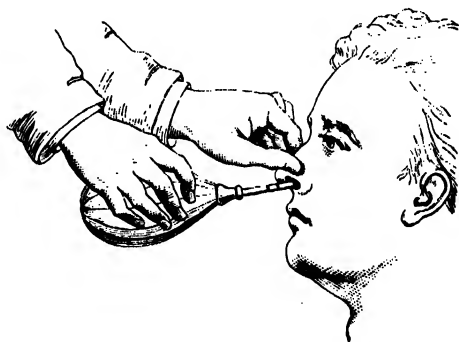


FIG. 42.—POLITZER'S BAG APPLIED.

or tube. The patient is now desired to swallow (the process having been previously explained to him if an adult), and immediately, as the larynx commences to rise with the hyoid bone, and the fluid is passing into the pharynx, the bag is forcibly compressed, and the air rushes into the tympanum.

There is no difficulty whatever in carrying out this simple manoeuvre, and even children get quite accustomed to the inflation if in the first attempts they are taken gently and gradually taught.

It is well to use a fresh piece of rubber tube, cut to cover the nozzle, with each patient, as it can be thrown into disinfectant solution and cleansed before use. Two precautions

must be specially insisted upon before the use of any nasal, aural, or throat appliance for the inflation or insufflation of the middle ear. The first is to secure the thorough disinfection of any nozzle, catheter, bougie, speculum, tongue-

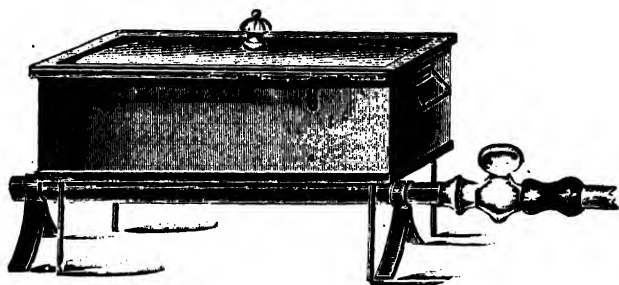
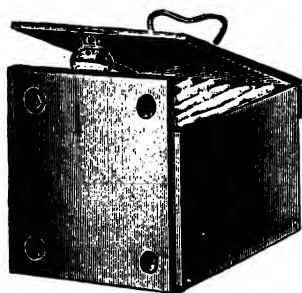
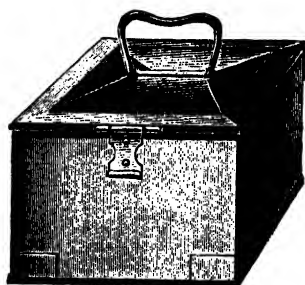


FIG. 43.—STERILIZER WITH TRAY FOR USE IN CONSULTING-ROOM

depressor, or other instrument that may be used for diagnostic or therapeutic purposes. With this object, all appliances that have been employed with one patient should be rendered aseptic before use with another. We keep a solution of



Open.



Closed.

FIG. 44.—CONVENIENT NICKEL BOX FOR PLACING IN A STEAM STERILIZER TO HOLD AURAL DRESSING.

alcohol with formalin ready to hand for placing such instruments in, but it is better that any that have been in any way infected should be placed in a small sterilizer and boiled. It is not necessary to emphasize the risk to the patient through neglect of such a precaution.

The second is to place a patient whom we are about to Politzerize, use the Eustachian catheter for, and inflate or wash out the tympanum of, in the sitting posture. This is not only necessary to secure greater steadiness on the part of the patient, but also in case of any sensation of reeling and giddiness following the inflation or injection.



END OF CATHETER.

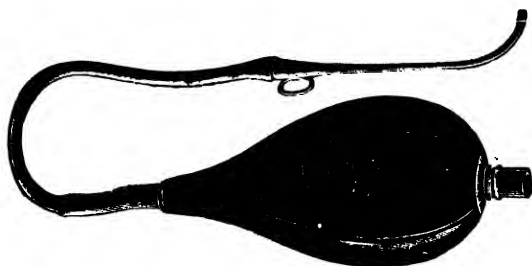


FIG. 45.—HAND-BALL BELLOWS WITH VALVE.

The Hand-ball Bellows.—This appliance is of use for ascertaining if the Eustachian catheter have entered the tube. When the catheter has been passed, the nozzle of the tube should be placed in its end, and if the catheter be



FIG. 46.—PROFESSOR LUCAE'S BELLOWS BALLOON.

a, Clip to allow exit of air; *b*, hook for attaching to button-hole; *c*, large balloon. The balloon *c* is distended with air from the bellows *d*. This is liberated by the clip *a*.

in its place, by squeezing the ball the air will be heard by the auscultation-tube to enter the tympanum. It is also of use in blowing fluid spray through the tympanic catheter. A larger bag, having a valve attached, is necessary for more forcible inflation.

Professor Lucae's Bellows Balloon.—This is a most convenient and useful instrument for inflation either by the nose or through the Eustachian catheter.

Lucae found that we may blow air into the middle ear by employing a movement which will cause the velum palati to hermetically close the naso-pharyngeal space.

'Such a process may be effected by a prolonged phonation of the vowel *a*, best pronounced in a nasal tone, which will cause the velum to rise, cut off the upper from the lower pharynx, and during this act air may be blown into the nares, and thence into the middle ear, by a powerful inflation with the hand-balloon.'

It will be found in many persons that the ear is easily inflated during this act, and, if so, in a much simpler manner than by the process of swallowing water. In some, however, this plan of Lucae fails. It is well to try both methods in those cases in which there appears to be a difficulty of inflating the tympanum. In cases where we suspect liquid accumulation in the tympanum, Politzer's plan will be found effectual, and may remove the serous collection. This is to give the patient a little water to keep in the mouth, and direct him to hold the head forwards and slightly to one side, and then, after the head has been held in this position for a minute, to inflate during the swallowing of the water. The tubal orifice thus opened permits the fluid secretion to pass out, and the position in which the head is held favours the passage of it in the direction of the Eustachian tube.

'Gruber, seeing that the tongue is pushed further back during the pronunciation of the consonants *h* and *k*, suggested that inflation should be practised while the patient pronounces the syllables "hick," "hock." The operator "sits in front of the patient, and the end of the nozzle of the syringe (the ball of which is held in one of the operator's hands) is passed to the depth of one-third of an inch into the nasal opening. The operator then, with the thumb and first finger of the other hand, closes the opening around the syringe nozzle most carefully, and while the patient utters one of the prescribed syllables ('hack,' 'heck,' 'hick,' 'hock,' 'huck,' 'hck'), the ball is compressed, and the air flows with a clearly perceptible noise through the tubes into the tympanic cavity.'

He claims for this plan these advantages: (1) Simplicity; (2) the avoidance of swallowing water in the act of deglutition; (3) a more prolonged inflation; and (4) that it is better adapted for self-treatment.

There is another plan, which generally answers better—namely, to direct the patient to close the lips and make a forcible effort at expiration. If the bag be then gently squeezed, the air readily enters the tympanic cavity.

We have devised for purposes of auto-inflation, or insufflation of a vapour into the tympanum, an inflating-bag. The idea of inflating the

tympanum with respired air was originally that of Löwenberg. He showed that a greater interchange of gases is likely to take place when the warmer and heavier air of respiration reaches the tympanum than in the case of ordinary atmospheric air. By the appliance shown (Fig. 47) respired air can be readily inflated. Valves in the nasal and aural tubes regulate the entrance and exit of air. The bag being compressed, it is filled with air by the patient breathing into it through the aural tube. This is then dropped, and, the nasal piece being applied, the bag is compressed in the usual manner, the valve in the aural tube preventing any passage of air in this direction. By attaching the aural

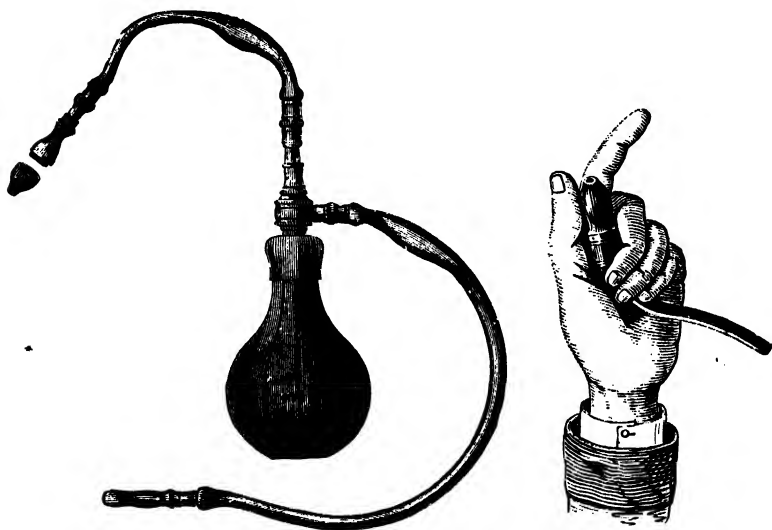


FIG. 47.--AUTHOR'S AUTO-INSUFFLATOR. IT HAS ALSO MOUNTS FOR NOSE, MOUTH, LARYNX, AND EUSTACHIAN CATHETER.

Showing method of holding nasal-piece in introducing it into the nostril; the thumb secures it in and closes on it in the nostril, while the forefinger is ready for closure of the opposite nostril.

tube to any receptacle, such as an inhaler or nebulizer, it aspirates the vapour, which can then in the same way be driven into the tympanum.

Directions.--The person wishing to inflate places with the thumb and middle finger of the left hand the vulcanite nose-piece in either nostril, closing the other with the forefinger of the same hand. By a sharp act of compression made with the right hand, he drives the air into the open, or partly open, Eustachian tube just at the commencement of the second act of deglutition. Any surgeon trying this bag in the manner described on himself will find how effectual it is, and that the simple attempt to swallow a little saliva is quite sufficient without taking any water into the mouth. For diagnostic purposes it is not as powerful an inflator as the

ordinary Politzer's bag, but it is quite powerful enough for any patient to use and is easily managed.

The Eustachian Catheter.—Dexterity in the use of the Eustachian catheter and bougie is essential. Catheterization is necessary in cases of Eustachian obstruction, in the treatment of collapse of the tube and drumhead, and for making therapeutical application to the middle ear.

Students should not neglect to learn the method of using the instrument any more than they do that of the urethral one. Awkwardness is as hurtful, and gentleness combined with delicacy of touch as indispensable, in the one as in the other. It is a matter for surprise that so many surgeons still neglect to practise catheterization of the Eustachian tube. It

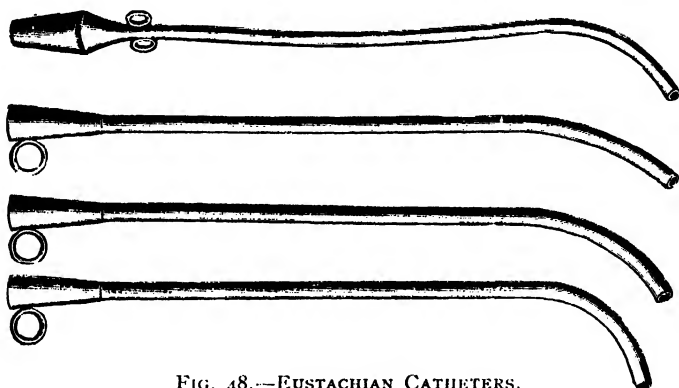


FIG. 48.—EUSTACHIAN CATHETERS.

is true that it requires some little experience to introduce the instrument with ease and celerity; but with ordinary care and tact no harm can be inflicted in its passage, and there is nothing in the operation which a little practice will not enable everyone who possesses any manipulative skill to overcome.

We have never had an untoward result follow its employment. Gentleness, avoidance of all force, and an acquaintance with the anatomical relations and abnormalities of the entrance to the tube, are the essentials to success. Any skilful surgeon should be able to pass it with facility and with either hand. Frequently a patient, when he finds the sensitive anterior part of the nose touched by the catheter, raises his hand to arrest the operator's. It is well to have the left hand in readiness, so that while we restrain the

patient with the right, we continue quickly the passage of the catheter with the left hand, to which we transfer it. The errors which we have seen generally committed by beginners are these: The catheter is taken hold of in too clumsy a manner and held too firmly during its introduction



FIG. 49.—SECTION OF NOSE SHOWING THE CATHETER IN THE INFERIOR MEATUS (AUTHOR).

it is introduced too slowly, and carried into the middle meatus instead of the inferior; it is either not passed far enough back, or is turned towards the ear, anterior to the orifice of the tube, or, when passed back to the pharynx and turned into the fossa of Rosenmüller behind the faucial orifice of the tube, it has not been drawn sufficiently forward.

It will be found useful to have catheters of various sizes and curves ready at hand. Both vulcanite and silver instruments are made, and can be curved to suit each case.

The short catheters, about $4\frac{1}{2}$ inches long, are preferable, as they do not protrude so far after passing, and are not so likely to have the beak out of the tubal orifice.

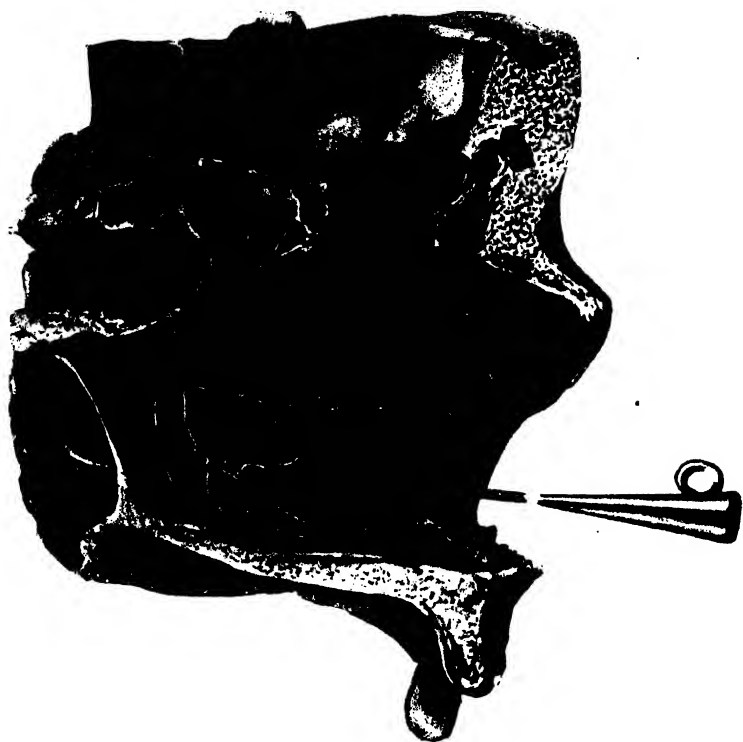


FIG. 50.-- SECTION SHOWING THE BEAK OF CATHETER IN RELATION TO THE SEPTUM POSTERIORLY (AUTHOR).

A spray of a 4 per cent. solution of cocaine will facilitate the passage of the instrument, or the meatus may be lightly mopped out with a cocaine solution by means of the Eustachian forceps.

The catheter, held lightly between the forefinger and thumb of the right hand, has its curved point, directed downwards, introduced into the nostril; the hand being then raised, the catheter is carried lightly and quickly

horizontally along the floor of the nares, all force being avoided, until the pharynx is touched posteriorly. The instrument is then rotated upwards and outwards until the ring on the outer end points directly outwards and slightly upwards; it is then drawn gently forward about half an inch, and will be felt in the Eustachian tube, after having ridden over the posterior lip, and we verify the success of the operation by inflation with the Eustachian bellows. A plan which it is well sometimes to adopt if we miss the orifice is to turn the catheter inwards, withdrawing it from the pharynx until we feel the beak against the vomer, and then, by rotating the catheter outwards and upwards, to turn it towards the Eustachian tube.

The surgeon may readily fall into error with regard to air entering the tympanic cavity when he listens to inflation with the auscultation tube. He may think the catheter is in the Eustachian tube when its beak is only in the neighbourhood of the tubal orifice, and hence that air is entering the tympanum on inflation when it is not. A more likely error is that though he may insert the catheter correctly, yet air may not pass beyond the wide part of the tube. The false sound produced in the first instance may be learned by anyone with the Eustachian bellows and catheter. The sound reaching the surgeon's ear in the second case is far more distant, and altogether distinct from the characteristic rush of air heard when it directly enters into the tympanic cavity. The patient quickly learns to distinguish not only when the catheter is in the right position and air is entering the tympanum, but also to tell when the inflation is satisfactory or otherwise.

The careless or rough passage of the catheter, followed by too powerful an inflation, may lead to laceration of the mucous membrane and emphysema of the cellular tissue of the pharynx

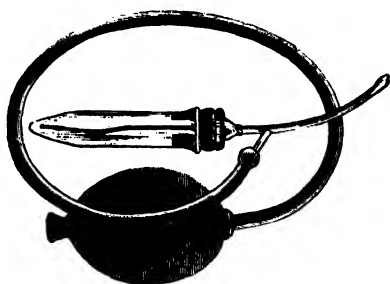


FIG. 51.—COCAINE SPRAY FOR NOSE OR EAR.

and parts about the larynx, or, as proved by Voltolini, to pneumothorax and consequent collapse of the lung.

Should emphysema have occurred, an incision should at once be made into the swelling. While free Politzerization in the great majority of cases is the most effectual method of inflating the tympanic cavity, it is not uncommon for inflation by the catheter to do good where it fails. This remark applies to cases of stricture or closure of the tubal wall from

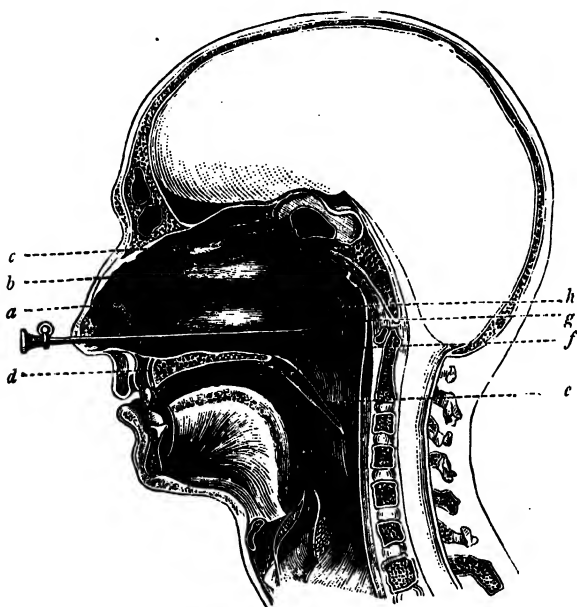


FIG. 52.—EUSTACHIAN CATHETER (DIAGRAMMATIC) IN POSITION (POLITZER).

a, Inferior spongy bone; *b*, middle spongy bone; *c*, superior spongy bone; *d*, hard palate; *e*, velum palati; *f*, pharyngeal wall; *g*, Rosenmüller's fossa; *h*, posterior lip of Eustachian tube.

tumefaction of the mucous membrane. In these latter the greatest benefit is derived from the use of the catheter and bougie. By passing a fine Eustachian bougie through the catheter into the Eustachian tube, we succeed in opening the latter, and the subsequent inflation is more easily secured. The bougie should be marked to indicate the degree of its protrusion from the catheter. (In the chapter on Middle-Ear Affections the therapeutical uses of the catheter and bougie are dealt with.)

The double-curved catheters, first devised by Noyes, passed from the opposite nostril, where there is an abnormality in the vomer or turbinal bone and septal obstruction in the nasal passage of the side corresponding to the affected ear, are occasionally very useful.

A catheter with a double curve for the right and left Eustachian tube (Fig. 53) enables us, as a rule, to disregard those obstacles of the septum and vomer which prevent the passage of the instrument. An ordinary silver catheter may be readily given this same double curve for the right and left side.

The catheter is held in the right hand for the right nostril, and *vice versa*, at a right angle with the nose, on a line with the floor of the meatus, the back of the hand being turned upwards; the beak of the catheter is introduced at the inner side of the corresponding nostril. The catheter, kept close by the septum, is carried for a short distance backwards, when the hand is brought down, the direction of the catheter being gradually changed to that of the horizontal one maintained in passing the ordinary catheter. With a sweep it is carried round the vomer posteriorly, and then rotated inwards, the point readily entering the Eustachian tube of the opposite ear.

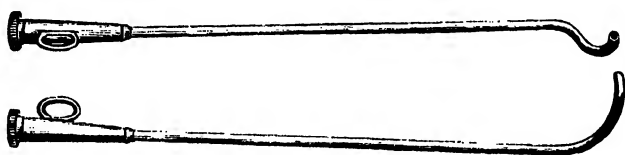


FIG. 53.—NOYES' EUSTACHIAN CATHETER.

A forceps devised by Turnbull is very useful for wiping the faucial orifice of the tube and clearing away any matter that may obstruct the orifice. With it we can apply warm soda and glycerine in solution, or liquid vaseline with cocaine, before introducing the catheter, or make any other application for therapeutic purposes. It is passed in the same manner as the Eustachian catheter.

A small bag with a tube and nozzle may be quickly applied to the catheter for washing out the orifice and cartilaginous portion of the tube.

The Eustachian Bougie.—The bougie is made either of celluloid or gum-elastic. The latter is preferable, as not being so stiff and less liable to break, though this accident is not likely to occur with any care. They are made of various sizes, from a line upwards, and bulbous at the ends, which are of different thickness. The Eustachian catheter having been passed, and its presence in the Eustachian tube

ascertained by inflation, the length of a portion of the bougie corresponding to that of the catheter being known, the bougie is passed through the catheter very lightly, and, if there be no obstruction, readily enters the Eustachian tube. If, however, there be stricture or other source of obstruction, we feel, as we have said, the point of the bougie arrested. If the



FIG. 54.—TURNBULL'S EUSTACHIAN FORCEPS.
a, Sliding clip.

length of the bougie, as compared with that of the catheter, should have been carefully marked beforehand on the bougie, we now know the distance from the point of the catheter to the seat of the obstruction. A smaller instrument is now

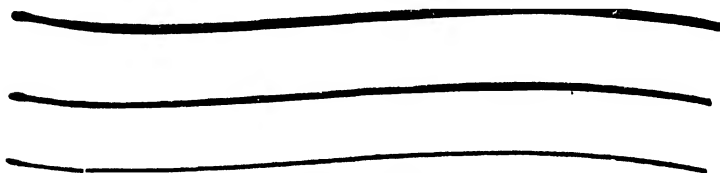


FIG. 55.—EUSTACHIAN BOUGIES.

tried, and we endeavour to pass the seat of obstruction by manipulating the bougie lightly and much in the same manner as we would a tight stricture of the urethra, drawing it backwards and passing it forwards with a gentle movement,

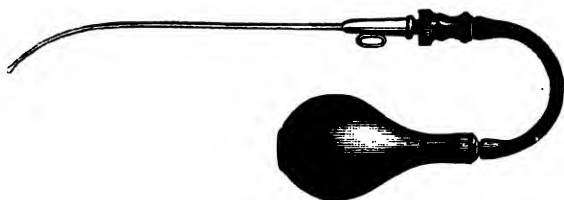


FIG. 56.—SMALL BAG WITH TUBE AND NOZZLE ATTACHED TO THE CATHETER FOR DOUCHING THE ORIFICE OF THE EUSTACHIAN TUBE.

and giving it a slight lateral tap against the wall of the tube. Blood should not appear on the bougie after any attempt to pass it, and should there be a sign of it, inflation should not be practised. We may often fail at the first two or three sittings to pass the instrument. We know that we have

succeeded by the length, as measured from the first mark on the bougie to the distance as shown by the second, which is noted when it has passed through the obstruction, a distance which should not exceed from 1 inch to $1\frac{1}{4}$ inches. The bougie is now withdrawn, and the tympanum is inflated. The results are various. At times the improvement is immediate, and to a certain extent is maintained until the next sitting—say on the following day—and by repeating this practice for a number of times, varying with the class of case, the improvement may increase and remain permanent. Injections of vaseline, alkaline solutions, or pilocarpine, oftentimes assist. In other cases the immediate improvement is great, but has all disappeared before the patient's next visit. Here, naturally, we conclude, especially if the bougie should have passed



FIG 57.—BALL WITH TUBE ATTACHED TO ATTIC-PIPE FOR BLOWING POWDER INTO OR WASHING OUT THE ATTIC (BEZOLD).

easily, that the cause of the deafness is to be found in tubal collapse, associated probably with a collapsed condition of the drumhead. It is in such cases that faradization of the tubal muscles, associated with the passage of the bougie, does so much good. In another type of case there is little or no discernible improvement either after the bougie or inflation. Here we may conclude that there is irremediable middle-ear affection, and its association with disease of the labyrinth or auditory nerve can invariably be proved by other tests.

The Tympanic Catheter.—This is a thin, flexible catheter made of strong silk covered with indiarubber, from 16 to 18 centimetres in length, and of $1\frac{1}{4}$ to $1\frac{3}{4}$ millimetres in thickness. The aperture at the terminal end of the catheter is at a short distance from its point. It is passed into the Eustachian tube through the ordinary Eustachian catheter, and with the same precaution as in the case of the bougie.

It is indispensable for the introduction of fluid into the Eustachian tube and tympanum.

Weber-Liel pointed out the class of case in which the use of a catheter was specially indicated :

In cases of long-continued chronic catarrh, where old inspissated and viscid accumulations are present in the folds of the membrana tympani



FIG. 58.—TYMPANIC CATHETER.

in the spaces between the malleus, in the anterior and upper walls of the tympanic cavity, in the niches of the labyrinth, or around the articulations of the ossicles, giving rise to decreased mobility both in the membrane and ossicles. Experiments on dead and living subjects show that the simple air-douche and the ordinary methods of treatment are not sufficient



FIG. 59.—TYMPANIC CATHETER PASSED THROUGH THE ORDINARY EUSTACHIAN CATHETER.

to wash them away. If the passage through the Eustachian tube be difficult, even the strongest air-douche loses much of its power through the increased friction, and the injected fluid is sent, not where it is intended, but to the bottom of the tympanic cavity or into the cells.

It was with this object he devised his koniantron (Fig. 61), which practically consisted of a tympanic catheter adapted

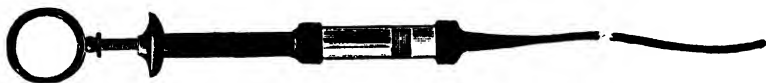


FIG. 60.—TYMPANIC SYRINGE AND CATHETER.

to a Pravaz syringe, the latter being used for injecting any required fluid through the catheter.

The silver and tympanic catheters being in position, the syringe is applied to the catheter, and a quantity (from 10 to 20 minims) is injected. By the subsequent use of the hand-ball bellows, the nozzle of which is fitted to the catheter, the fluid is forced as spray into the tympanic cavity.

The Ear-Syringe.—It is necessary to have an effective syringe. For the removal of cerumen we prefer the screw nozzle, as it does not become loose like the one that merely fits

on, and it is more efficacious than a nozzle with a larger bore. For the same syringe we can have made a nozzle of vulcanite, with an indiarubber cap. It is useful for the treatment of cases of perforation of the membrane. The conical india-rubber end fits well into the meatus. The patient is directed to hold the head forwards over a vessel, and the stream is passed through the ear, and flows from the Eustachian tube through the nostril. We are thus enabled to wash out the cavity of the tympanum, remove secretions, and clear the Eustachian tube with disinfecting solutions. The ear syringe should be well made of nickel-plated metal with metal piston. Such a syringe can be quickly sterilized and rendered aseptic.

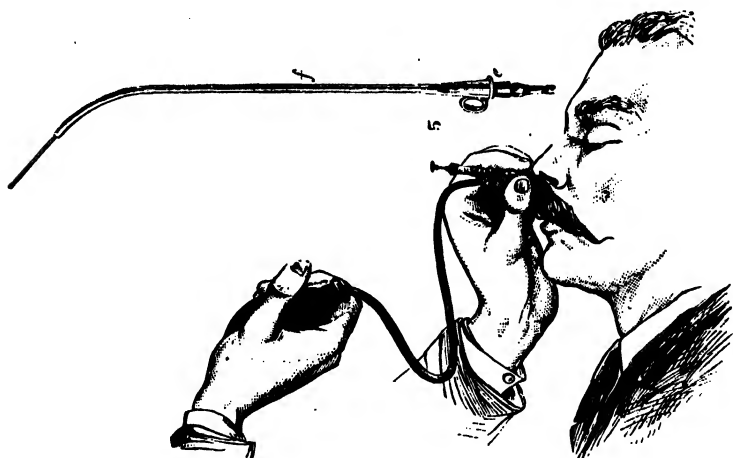


FIG. 61.--KONIANTRON, WITH THE HAND-BALLOON APPLIED TO THE PRAVAZ SYRINGE AND CATHETER.

The interior of any syringe must be kept scrupulously clean. The piston should be regularly washed in a disinfectant solution (formalin is the best), and boric vaseline used to lubricate it. Such precautions are absolutely essential, otherwise fungi and organic particles may be introduced from the interior of the syringe. To see any particles that may be removed from the ear in syringing, a glass slice is the best to use, as any slight degree of milkiness of the fluid is at once discerned. An ear-shoot to direct the fluid is necessary.

For douching the ear a small bag-syringe is required. We employ those with a metal nozzle fitted with a bayonet

joint, and have had one made on the same principle with a tube and nozzle, which is convenient for the patient's own use (Figs. 62 and 63).



FIG. 62.—ASEPTIC EAR SYRINGE AND MOUNTS.

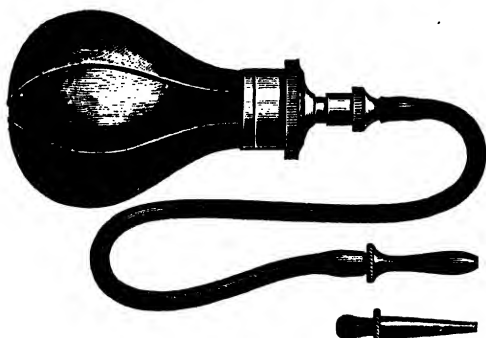


FIG. 63.—AUTHOR'S BAG SYRINGE, WITH BAYONET-JOINT FOR PATIENT'S OWN USE.*

The Aural Probe or Cotton-wool Carrier.—An aural probe or cotton-wool holder should be used for the purpose



FIG. 64.—AUTHOR'S ORIGINAL AURAL PROBE, ARMED AT BOTH ENDS WITH WOOL.

a, For application of chloro-acetic or chromic acid; *b*, for cleansing purposes.

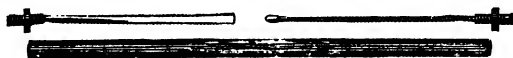


FIG. 65.—AUTHOR'S PORTABLE FLAT PLATINUM AND SILVER SCREW END NASAL AND AURAL PROBE.

Useful for examination of the meatus and nose and the application of acids.

of thoroughly cleaning and drying the meatus and membrane after using the syringe.

Forceps.—For wiping out the meatus, detaching portions of epidermis and cerumen, drying the passage after syringing, or, if there have been bleeding, removing small granula-

* Made by Messrs. Ash, Dental Company, Soho.

tions, certain forceps are useful, three of which are here shown.

In applying nitrate of silver with the point of the aural probe, a small platinum crucible is useful.

The silver should be melted over a lamp, and a fine probe

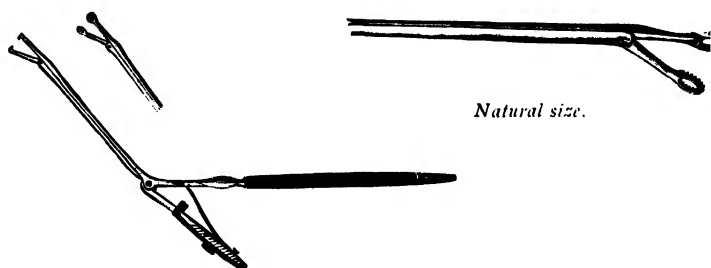


FIG. 66.—LEVER ALLIGATOR AND RING FORCEPS.

lightly dipped in, when a thin coating of the silver is left on the end of it.

Artificial Aids, Ear-Trumpets, etc.—There must ever remain a number of patients who consult us for deafness for whom we can only advise some artificial aid to assist



FIG. 67.—WILDE'S FORCEPS.

the hearing. The present state of our knowledge in differentiating the conditions benefited by the various kinds of trumpets, ear-tubes, auricles, audiphones, dentaphones, etc., is not satisfactory.

It is not possible to speak positively of any particular form

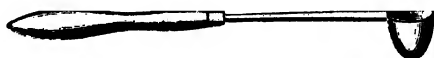


FIG. 68.—SMALL PLATINUM CRUCIBLE.

of ear-trumpet, inasmuch as it is purely a matter of experiment with each individual case which one is found to give the best results. We figure here a few of those we have found most useful in practice. The light, conical folding trumpet, made of japanned tin, is one of the best, and most

convenient for the pocket. The small, bell-shaped trumpet is also handy and portable.

The folding audiphone of Rhodes is simply a fan made of thin vulcanite, which folds up, one end of which is applied to the teeth, while, with the handle held by the listener, the convex surface is presented to the speaker. A common Japanese fan makes a very good audiphone.

Most patients object to the conspicuous nature of the

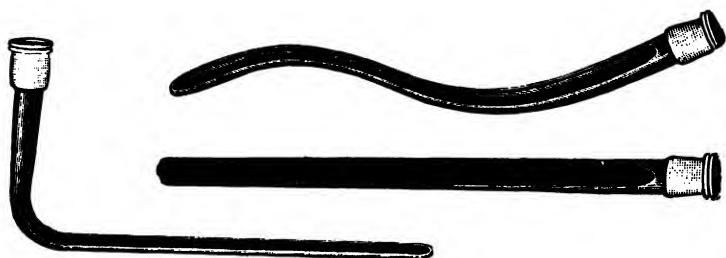


FIG. 69.—AUTHOR'S NASAL BOUGIES FOR NASAL EXPLORATION AND DILATATION.

These are made of thin lead coated with gum elastic; they can be bent into and retain any shape (Arnold).

audiphone, and the majority hear best with a trumpet of some kind. Anyone can make an audiphone for himself from a piece of very thin ash-wood, which is the best for the purpose. This is steamed, and, when warm, given the suitable curve. The teeth must be separately tried to test

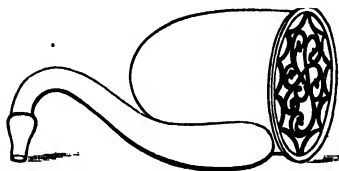


FIG. 70.—EAR-TRUMPET.



FIG. 71.—POLITZER'S SYREN.

the conduction. The instrument must touch a natural tooth. The patient must then be spoken to in different tones. He may be tested by the piano and by singing.

The advantage derived from small instruments worn in the meatus is generally very slight. Politzer devised a small trumpet to diminish as much as possible the loss of the

sound-waves during their reflection, and to conduct them into the auditory meatus.

We have had in some patients a satisfactory result with this little trumpet. It must fit the meatus well. The instru-

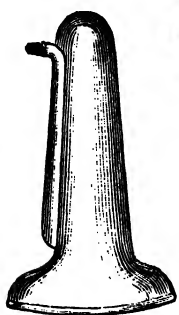


FIG. 73.—SMALL VULCANITE TRUMPET.

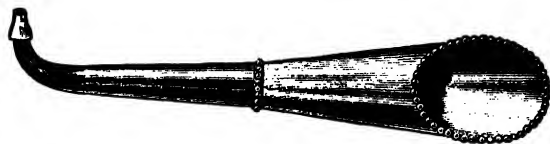


FIG. 72.—FOLDING EAR-TRUMPET.



FIG. 74.—POLITZER'S EAR-TUBE* (ACTUAL SIZE).

ment is here represented. It is made of flesh-coloured vulcanite, and is not conspicuous. The narrow part fits into the ordinary meatus, and the wide portion is turned towards the concha. There are three different sizes, the

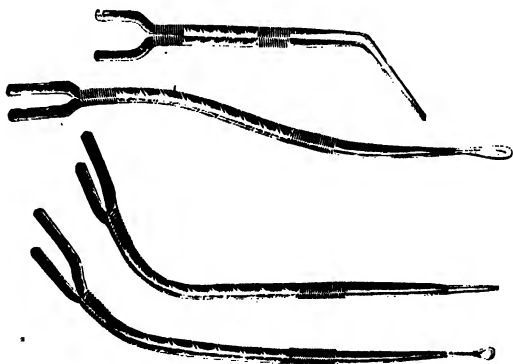


FIG. 75.—GALVANO-CAUTERY KNIVES AND NEEDLES FOR USE IN THE CASE OF GROWTHS AND IN PARACENTESIS OF THE MEMBRANE.

larger measuring in length $2\frac{1}{2}$ centimetres; at its outer opening it has a diameter of 12 millimetres, and at the inner aperture it has a diameter of 5 millimetres.

The dentaphone consists of a small vulcanite clip connected

* Hawksley, Oxford Street, W.

with a small circular vulcanite box by a string, somewhat like the ordinary toy telephone. The proportion of cases in which any such aids improve hearing is very small. They are



FIG. 76.—NASAL PROTECTOR AND VAPORIZER.

The interior is filled with absorbent wool, on which any medicament may be dropped. The perforated side is directed out, and the protector fits snugly inside the nostril. It is imperceptible, and is easily put in and taken out.

more frequently made the means of attracting simple-minded and unwary persons, who are tempted to try any or every

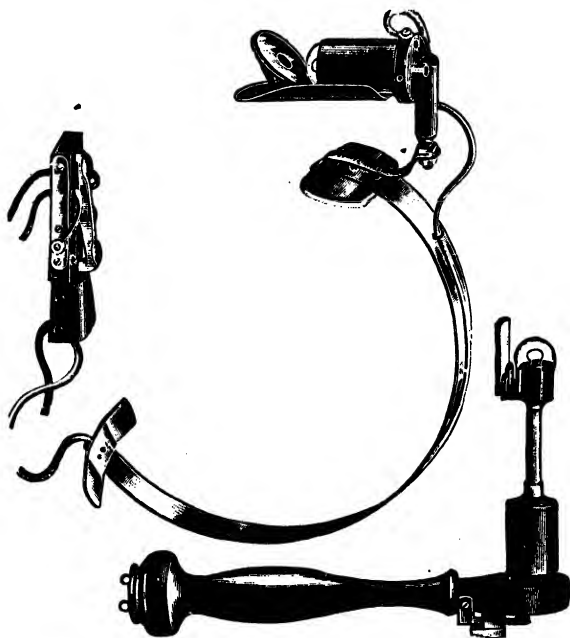


FIG. 77.—LAMPS FOR ELECTRICAL TRANSILLUMINATION.

advertised means to improve their hearing, and are readily imposed upon.

Transillumination Lamps.—Should transillumination for examination of the accessory cavities, the antrum and frontal

sinuses, be required, special lamps, such as those here figured, are used. The light is either placed under the orbital margins or in the mouth. The light reflected through the unaffected cavities — frontal, orbital, or maxillary — shows bright in contrast with the corresponding darkened spaces which are affected by disease. The test, however, requires verification.

The Galvano-cautery.—Cautery points and knives are essential for both aural and nasal practice.

Whenever electricity is available, a transformer for the use of the cautery should be availed of.

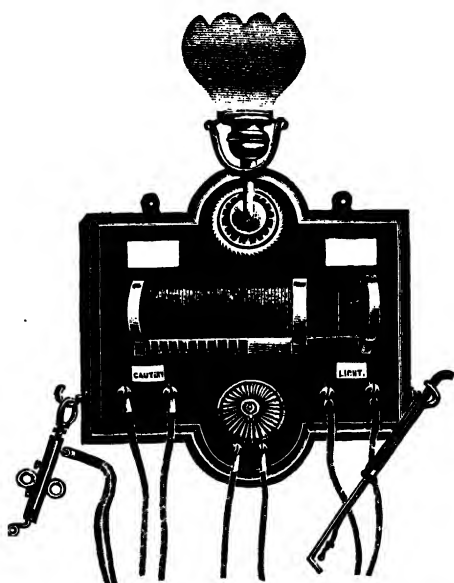


FIG. 78.—TRANSFORMER LIGHT AND CAUTERY.

CHAPTER VII

AFFECTIONS OF THE EXTERNAL EAR

By H. MACNAUGHTON-JONES

Affections of the Auricle.

MALFORMATIONS.

Congenital.

Microtia.	Polyotia.	Fistula.
Macrotia.	Fissure.	Coloboma.

Acquired.

Eczema.	Epithelioma.	Abscess.
Herpes.	Fibroma.	Othæmatoma.
Herpes zoster.	Keloid.	Traumatic
Erysipelas.	Angioma.	deformities.
Lupus.	Cystic degenera-	Injuries.
Syphilis.	tions.	Tophaceous
Frost-bite.	Perichondritis.	tumours.

Affections of the External Auditory Canal.

Congenital malforma-	Otitis externa (chronic).
tions.	Polypus.
Abscess of.	Hyperostosis.
Atresia of.	Exostosis.
Stenosis of.	Occlusion of by-growths
Absence of cerumen.	or false membranes.
Excess and impaction of	Otomycosis.
cerumen.	Cysts.
Foreign bodies in.	Epithelioma.
Furuncle.	Condyloma.
Otitis externa (acute).	Syphilitic ulcer.
	Traumatisms.

Affections of the external ear include abnormalities, diseases, and injuries of the auricle and external auditory meatus. Some of these, as implicating both auricle and the external auditory canal, may be considered under the one heading.

Malformations.—These may be divided into congenital and acquired. The former are unilateral or bilateral. They are due either to an arrested development or to abnormal enlargement or excessive growth. The former condition is called 'microtia,' and the latter 'macrotia,' while to the existence of supernumerary auricles and multiple growths from, or adjacent to, the auricle, as in the case of an auricular appendix, the term 'polyotia' is applied. Such supernumerary auricles may be situated in any abnormal position, as on the neck or cheek. Take, for example, such cases as the following: An adult had the upper portion of the auricle largely developed and perfectly flat, with no helix (the removal of two triangular portions of the cartilage, with an equal portion of the skin, left a very presentable ear). In another, the whole of the upper part of both auricles was deficient, and the skin formed a complete septum over the opening into the meatus, the cartilaginous lining of which could, however, be distinctly felt. Fig. 79 shows the auricle of a child of five years of age. There was no meatus, the hearing was nil, that of the other ear normal. In a child a few months old there was an entire absence of the auricle, as well as of the meatus. Other congenital abnormalities are seen in the form of fissure in some portion of the auricle, more often in the lobule, and congenital aural fistula is still more rare. When present, it is more frequently found in the neighbourhood of the tragus, varies in depth, not generally exceeding from a quarter to half an inch, and occasionally contains small cysts, which may suppurate, or the fistula itself may become the seat of purulent inflammation. In many cases of congenital malformation, cosmetic operations are called for, the nature of which will depend



FIG. 79. — AURICLE IN CASE OF CONGENITAL ABSENCE OF MEATUS (AUTHOR).

upon the character of the deformity. Such operations must be performed with care and nicety, the danger being the removal of too much rather than too little. They consist in the removal of the superabundant cartilage with the necessary amount of skin, and the careful adjustment by sutures of the edges of the wound. As a rule, such wounds heal well if ordinary precautions be taken, the part being first rendered thoroughly aseptic, and all bleeding being arrested before the sutures are applied, these preferably consisting of fine silk-worm gut. The auricle is then covered with sterilized iodoform gauze and cotton-wool under a suitable bandage. An unsightly and projecting auricle may be treated, as recommended by Gruber, by two concave incisions 5 cm. in length, the posterior 1 cm. backwards over the mastoid, and another 1 cm. in front over the auricle, the concavities facing each other. The incisions are united above and below. The intervening skin is removed, while that at the edges is loosened for a short distance, and then sutures are applied. In the case of fistula, the lining of the entire fistulous tract, should operation be called for, must be removed. We have known cases of projecting auricle in young children cured by the constant use at night of an aural truss.

Eczema.—Eczema of the auricle differs only from this skin disease elsewhere as it is influenced by the anatomical structures of the part. The thicker skin, the subjacent cartilage, the presence of glands, give to the affection characteristic appearances, according to the portion of the auricle or meatus affected. On the posterior surface of the auricle, at its edge, and over the lobule, it assumes the same moist vesicular or pustular appearance that we are familiar with in other parts, and the stages of the affection are similar. In children particularly it has more the character of intertrigo, and the exudative stage is frequently followed by a rawness and denudation of the surfaces. Here the attack is generally acute, leaving an irritating discharge which excoriates the adjacent surface, and when this occurs in the cleft between the auricle and the mastoid process, it is with difficulty that we can examine the surfaces, and with the swelling of the auricle these become apposed, making it

more difficult to keep them apart. The auditory canal, if not protected, is liable to be filled with a muco-purulent discharge; epidermal scales collect in it, and the glands in the neck are often enlarged. The usual crusts form, harden, and become more tenacious. In some instances there is considerable œdema, with infiltration and thickening of the lobule and helix. In children we find eczema frequently present in connection with, and as a result of, the exanthemata, whooping-cough, and the tubercular diathesis. It is more frequently seen in the poorer classes, and coexistent we often find phlyctena on the conjunctiva. The child has the typical anæmic and debilitated appearance, with the peevishness of temper which is generally associated with it. The other form of eczema, attacking both the meatus and auricle, is met with in adults and persons advanced in life. The meatus and surrounding skin are the seat of a dry eczematous desquamation. There is itching and irritation of the canal, and not necessarily moisture or discharge. The auricle is often swollen and sensitive, and there may be slight cracks or fissures under the dry epidermis. The swollen condition of the skin contracts the lumen of the canal, and with its contained collections causes deafness. Should this state be neglected, the drumhead sooner or later becomes affected, while tenacious and adherent layers of dead cuticle cover its surface. This is the appearance of ear we often find present in persons who come affirming that they are suffering from 'gout in the ear.'

In its mildest form it is only the entrance to the meatus and inner surface of the antitragus that is affected, and here there is a dryness with desquamation, or there may also be a slight sticky discharge.

Another troublesome variety is that chronic form of eczema which we have described under the name of 'inveterate.' It is a chronic type of eczema, in which a thick and hard scab forms over a most inveterate and highly ichorous discharge. This crust clings with great tenacity to the part, and is with difficulty removed. When this is done, the fluid which lies concealed by the scab is nearly transparent and straw-coloured. The entire helix is involved, and the ulceration extends so

deeply that there is a loss of substance, and perhaps permanent disfiguration of the lobe.' In one case under our care there remained considerable deformity from a long-continued and oft-recurring attack of the kind above described. The auricle was marked with permanent scars and was destroyed in parts.

In any case of aural eczema, the first consideration is the constitution of the patient, whether child or adult. In children mild alteratives, with such tonics as the lime salts, cod-liver oil, the syrup of the iodide of iron, and other iron preparations, are indicated. The internal administration of a few drops of liq. arsenicalis with the meals has often a good effect. But the essential element in the treatment consists in the attention paid to the diet and general surroundings of the patient. Simple and plain diet, plenty of milk, and a little oatmeal in the mornings, with the avoidance of all trashy food, attention to the cleanliness of the child's person, with sufficient outdoor exercise, should be the directions to parents.

If there be crusts, these should be softened and separated by a vaseline or paroleine pack applied at night. (A few pieces of soft linen rag soaked in the paroleine, and covered with oiled silk or gutta-percha tissue.) After a few days the exposed surface may be treated with some mild stimulating astringent ointment, such as lanolated benzoate of zinc with carbolic oil and vaseline, or liq. carbonis detergens and liq. plumbi diacet. and vaseline, or a little of the ordinary calomel wash. If there be much discharge, particularly if the skin between the attachment of the auricle and the mastoid be raw and moist, a lotion of calamine and oxide of zinc in rose-water applied during the day, the powder being allowed temporarily to dry on the part, will be found useful.

In the acute attack of eczema in the adult the same rule applies. Early administration of saline aperients, attention to the diet, protection of the exposed auricle by soothing packs of weak lanolated ichthyol with paroleine, and, if there be much exudation, the calamine and zinc lotion to keep the surface dry, are useful. The powder from this latter is sponged off gently at night with some warm starch and soda-water, after which a lanolated zinc oxide and benzoate ointment with

ichthyol is applied. We may substitute for such an ointment that of weak oxide of mercury, or the oxide of zinc, bismuth, and boric acid. (See Appendix for other ointments and lotions.)

In the more chronic and inveterate cases the treatment we have found of benefit is much as follows: If there be a

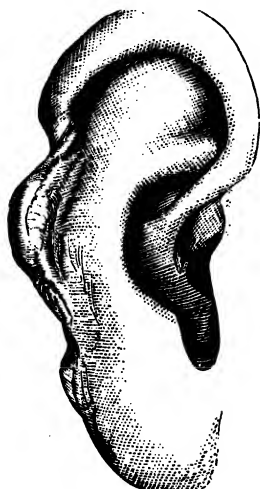


FIG. 80.—AURICLE OF PATIENT WHO HAD SUFFERED FOR YEARS FROM RECURRENT ATTACKS OF SAME AFFECTION; DRAWN AFTER COMPLETE HEALING OF THE EAR, SHOWING THE EXISTING DEFORMITY (AUTHOR).



FIG. 81.—AURICLE OF PATIENT SUFFERING FROM INVETERATE ECZEMA (AUTHOR).*

hard and tenacious scab, we must soften it by preliminary packing, as already described, and supplement this by scraping off the scab and thorough cleansing of the raw surface, which is then lightly touched with either chromic acid or carbolic acid. This removal of the scab is repeated as it forms, and the acid is very gently reapplied. The patient may himself use a lotion of calomel and lime-water after a few days, and smear a carbolized zinc and vaseline ointment on the part at night. A few applications of the acid are generally sufficient, and then the chloride of zinc (grs. xxx. ad ʒi.), applied after the removal of the scab, acts admirably. The crust should be removed daily and the raw surface dressed.

* 'Atlas of Diseases of the Membrana Tympani and Auricle.' J. and A. Churchill, 1879.

In all cases the general health has to be attended to, the gouty diathesis combated, and, if the urinary secretion indicate uric acid solvents, these should be administered. In inveterate chronic cases the combination of iodide of potassium with arsenic, or the mercuric perchloride, is of benefit. It is in such cases, when the patient can afford it, that a full course of a suitable spa-water, with the associated regimen, will be found of service. When the meatus is invaded, the auditory canal should be constantly and carefully cleansed with gentle douching, where necessary, with some alkaline solution, or such a disinfectant as weak hydro-naphthol, chloride of zinc with glycerine, boric acid, and alcohol. A nitrate of silver solution (grs. x. ad ʒi.) may then be applied to the cleansed wall of the meatus, should this have been invaded.*

Erysipelas of the Auricle.— Sometimes this affection assumes formidable proportions, occurring either in connection with erysipelas of the scalp or as a complication of some other aural trouble. We have seen it attacking both auricles, occurring in connection with a slight ecthymatous attack of the head and face. First one auricle was attacked, and then the other; finally, the inflammation spread to the scalp. The treatment does not differ from that of erysipelas elsewhere. The deafness that accompanies the disease disappears on the subsidence of the swelling. The meatus must be kept as clear as possible; a powder of equal parts of fine starch with boric acid and oxide of zinc kept to the part with gauze or muslin, or an application of equal parts of mild mercurial ointment and vaseline.

Herpes.— Herpetic eruptions on the auricle are occasionally found in the instance of delicate children, or in adults during some temporary derangement of the system, and rare cases of herpes zoster have been recorded. The treatment does not differ from that of these conditions when found elsewhere.

* **TOPHI IN THE AURICLE.**— Considerable deformity of the auricle may be caused by the formation of sodium biurate deposits. We had a case a few years since in which we removed a large number of these tophaceous tumours, at different sittings, in both auricles with a most successful cosmetic effect. They occurred in a patient suffering from gouty arthritis in various joints.

Lupus.—Lupus of the ear is comparatively rare, and has to be treated locally by incisions, curettage, the galvano-cautery, nitric acid, or caustic potash. The Röntgen rays may be employed.

Syphilis.—A primary syphilitic sore of the auricle is exceptionally rare, and can only occur as the result of infection from a scratch or bite. The secondary exanthem, however, is not uncommon, appearing with its manifestations elsewhere, and accompanying those on the face. The usual specific treatment, local and constitutional, is indicated.

Frost-bite.—When exposed to extremes of cold, the auricle is peculiarly liable to become frost-bitten, and, if it be imprudently treated, death of the pinna, with a considerable portion of the cartilage, may follow. Should the auricle be frozen, it is best to avoid any sudden transition of temperature, the patient being kept in the open air, and snow applied if procurable; if not, some iced water, or plain cold water, may be used. If the skin be destroyed or the cartilage exposed, boric vaseline, a mixture of paroline with lysol and lime-water, or other emollient or slight astringent applications, to be succeeded by more stimulating ones, are indicated.

Epithelioma.—Speaking generally, carcinoma is a comparatively rare affection of the auricle or meatus; but whenever in any sore epithelial proliferation is found, the carcinomatous appearances of which are distinct, free extirpation of the growth is the only remedy, and the auricle itself must be sacrificed, with the cartilaginous meatus, should the spread of the epithelioma demand it, while a plastic operation on the meatus is necessary to prevent its occlusion.

Keloid and Fibroma.—These are not common, but are occasionally found as the result of the wearing of an ear-ring. When such growths are present or any cystic degeneration, they must be neatly excised, which, as a rule, they can be, the wounds healing, with proper antiseptic precautions, readily and cleanly.

Angioma and Papilloma.—These are also rare growths, and the nature or extent of the operation for their removal must depend upon its size and depth. More uncommon still is the angiomatous auricle. Here the growth consists of

enlarged and convoluted bloodvessels having a free communication with the carotid. Operation in such cases is a most serious procedure, involving ligation of the common carotid artery, as well as removal of the deeper veins and a subsequent transplantation operation for the meatus.

Absence or Excess of Cerumen.—The healthy secretion from the follicles of the meatus varies greatly in different

individuals both in quantity and character. In some it is very soft and oleaginous, in others it is dry and has a tendency to crumble. The colour also is different, varying from a pale-yellow to black. It may be mixed with hairs or portions of epidermis. With the dry forms of secretion we often find eczematous conditions present.

Absence of Cerumen.

—There is no doubt that the popular notion that a 'dry ear' is indicative of deafness is, generally speaking, true. We find this dryness of the meatus and absence of secretion frequently present in those who suffer both from



FIG. 82.—PAPILLOMA OF THE AURICLE
(MACLEOD YEARSLEY).

Patient aged 62. Removal, with complete recovery.

middle-ear catarrh and accompanying affections of the labyrinth. It is more commonly observed in old persons, and indicates some morbid condition of the trophic nerves of the ear (Politzer). It is a frequent accompaniment of catarrhal appearances of the membrane and ossicles, and is often present in obstinate cases of tinnitus. Some emollient application, as glycerine, white vaseline, or an alkaline lotion, may relieve the sense of dryness or itching.

Excess of Cerumen.—Excess of wax deserves special attention on the part of the surgeon, as it is so common a cause of deafness, and is so frequently found complicating other pathological changes in the ear.

Causes.—It may be attendant on a narrow external orifice, which favours its collection. The use of towel-ends and various ‘picks’ for the ear favours the collection and impaction of wax. Imperfect cleansing of the ear after the free use of soap in washing is another cause of the collection of wax. An inflammatory state of the meatus is often seen with cerumen, so much so that we may look on a chronic form of dermatitis as both a possible cause and sequence of excess of cerumen.

Diagnosis and Symptoms.—The symptoms complained of by patients suffering from ‘wax in the ear’ are those of deafness, with a stupid feeling and some form of tinnitus, usually singing. Most ridiculous errors are often committed from overlooking this simple cause of deafness.

Nothing can be more exasperating than for a patient to return a long distance to a surgeon, and find that the source of all his blistering and leeching, and perhaps physicking, lay in a mass of easily removable wax. Yet this has occurred. The characteristic black shining surface of the wax can hardly be mistaken with any degree of care. The surface of an old and hard mass of impacted wax sometimes has a peculiar lustre, and may give to the inexperienced eye the idea that it is the membrane; but it is only necessary to mention this in order to prevent any surgeon from falling into so unfortunate an error. Two imprudent practices patients should be cautioned against: The first is the insertion of picks, rolls of towels, etc., into the ear to cleanse the meatus, which can only do harm, and insure the consolidation of any cerumen in the canal and its impaction on the membrane; the second is the habit of placing cotton-wool in the ear. Its presence is frequently overlooked, and, remaining in the meatus, it collects secretion, and may be hidden by wax or become embedded in discharge. The necessity for it after syringing or on going out into the cold air is obviated by the use of an aural protector. We have removed (with three layers of

wax) two layers of cotton-wool from the ear of a gentleman who was completely oblivious of its presence.

Treatment.—Free syringing is generally all that is required for the removal of this troublesome and common cause of deafness. The mass may not come away readily, and some time has to be spent in syringing, the addition of some carbonate of soda to the water assisting in the removal. This difficulty more frequently occurs when there has been inflammatory action in the meatus, or when the shed epidermis which envelops the cerumen is adherent to the wall of the passage. The removal of a plug of impacted wax is often expedited, after syringing a little time, by carefully grasping the mass with the rectangular or lever forceps, and thus withdrawing or loosening it. A few drops of liquor potassæ in glycerine, or a solution of carbonate of soda (grs. xx. ad ʒi.), dropped into the ear for a few nights, will help to soften hard masses of wax and epithelium.

While the grub of cerumen or waxy cast of the meatus is being washed out, the canal should be from time to time examined with a speculum. Much harm may be done if this step be not attended to, as the healthy membrane may be forcibly syringed on and injured. On the removal of cerumen, the membrane has generally a dull appearance, with an absence of transparency, and the surface of the malleus an injected look. The collection being removed, an interval of a few days will generally set things to rights, and, if this be the sole cause of the symptoms, nothing further is necessary. Should any tinnitus or pain persist, or if the deafness be not relieved, we must suspect other mischief, and proceed to examine the ear closely. It is well to inflate the tympanum a few times after the removal of the cerumen.

Insects in the Meatus.—Should an insect, such as an earwig, find its way into the meatus, the best thing to do is to pour in a little warm oil or glycerine, with some alkali, as potash or soda, so as to suffocate it, and then it can be washed out with a syringe.

Maggots from the larvæ of flies are sometimes found in the ear, and are seen like little white moving bodies. The best

treatment is to kill them with chloroform vapour, and then to pick them out with forceps.

Foreign Bodies in the Auditory Canal.—The first point in relation to foreign bodies in the auditory canal that the practitioner has to remember is the absolute harmlessness with which a substance may remain in it for a number of years. Instances have been recorded where this has happened, the foreign body remaining even as long as forty years without doing any mischief. We have ourselves removed with cerumen a grain of shot from the ear of a lady aged twenty-two, who at the age of three had put some grains of No. 5 shot in her right ear. These had evidently not all been removed, for some years afterwards, when the ear was being syringed for cerumen, another grain came away with the wax, and it was then thought that nothing more remained. Shortly before we saw her the ear felt uneasy, and she suffered from tinnitus, which syringing did not relieve. On examination, we found some hardened wax at the bottom of the meatus, occluding the drumhead. This yielded to syringing, but it was evident that there was still something of the nature of a foreign body remaining. On persevering with the syringe, another grain of shot, surrounded by a layer of wax and epidermis, came away. A week afterwards the membrane was normal and the hearing perfect.*

It may be laid down as an axiom in aural surgery that in the case of any arrested body in the meatus, where any space exists between the foreign substance and the wall of the meatus, the only agent which should be employed is water.

Many pages have been devoted to the consideration of this subject, and many opinions have been expressed as to the superiority of this or that method of removal and the advantage of this or that instrument over others, whether

* Some time since a patient consulted us for a germinating grain of corn in the bottom of the meatus. Its appearance with the transmitted light of the mirror was peculiar. It was quite adherent to the wall of the meatus. It had lain for some months in the meatus. The entire seed and a drawing of its appearance as seen before removal we exhibited at the Rhinological Society.

scoop or forceps. Our belief is that syringing is the one safe and certain method of removing foreign bodies from the ear. This is *the rule*; there may be some few and rare exceptions. We have, by careful, repeated, well-directed syringing, removed foreign bodies of all descriptions and shapes from the meatus by syringing alone. Amongst the have been glass beads of all shapes, shells, stones, pieces of chalk, berries, ears of corn, pieces of slate pencil, grains of shot, insects, etc. If the body be impacted, or if it completely occlude the canal, much will depend on the nature of the body, its shape, the material of which it is composed, the length of time it has lodged, the presence or absence of inflammation, the kind of instrument at hand. In all recent cases, those quickly brought to the surgeon, syringing is the best means to adopt. In all cases where inflammation is not present, no matter how long the body lies lodged, syringing is also the best means; and in cases where inflammation is present we prefer, as a rule, to wait, using means to subdue it, with gentle daily douching. If patience only be exercised, success in the end is almost certain.

To syringe the ear, the lobe should be held well back, the head sideways, the face turned slightly up, and the stream directed with sufficient force to pass between the foreign body and the wall of the meatus. We have known a piece of cobbler's wax used with success to draw a foreign body out. Glue applied with a camel's-hair pencil and allowed to harden on the body has been employed (Löwenberg). Dentist's cement may be applied with the same object. Quietness and firmness with friends, patience in using the syringe, extreme caution before resorting to any form of mechanical help, are the first essentials for dealing successfully with foreign bodies in the ear.

Any form of extractor, no matter how ingeniously devised, should be taken in the hand only when the nature of the substance justifies the belief that we can lay hold of it, or that by its position we can gently raise it from its bed. Such things as pieces of sponge, paper, bread, dried peas or beans, are examples of substances which are best removed by a forceps.

Instrumental Abstraction.—In the case of children and nervous adults, before attempting removal it is better to have an anæsthetic administered, and a careful examination should be made of the situation, nature, and shape of the foreign body, as well as its degree of fixation. This is best done after the injection of a 10 per cent. solution of cocaine. The flat platinum end of the nasal and aural probe (Fig. 65), which is very thin, and can be readily bent so as to pass between the wall of the canal and the foreign body, is useful for this purpose. We have known instances in which no foreign body has been present, yet where, unfortunately, efforts which proved disastrous were made to remove the supposed tenant of the canal. Take, for example, the mistake of assuming that the membrane is the head of a programme-pencil, and partially tearing away the drum-head in consequence.

Still persons are yet to be found who can be rash enough to employ clumsy force and ill-contrived instruments in the removal from the external meatus of what often is, even after a prolonged residence, a comparatively harmless tenant. The instrument suited for one occupant of the canal will be found valueless for another. The nature, shape, and position of the foreign body must be taken into consideration in the selection of any extracting instrument.

In our experience, the most frequent seat of the arrest of a foreign body is at the junction of the cartilaginous and osseous portions of the meatus. It becomes *arrested* here, or is driven against the membrane by extractive efforts. Every touch of an instrument, no matter how gentle, sends it further in; each forcible effort tends to further *impaction*. Of course, there are some bodies so small and so shaped that it is a matter of no difficulty to catch them with a forceps, pass a hook or wire behind them, and withdraw them; but it may be conceded that in the large proportion of cases foreign bodies are more firmly fixed in the ear by attempts at removal. If the body be not occupying the calibre of the canal, it lies in it, and there is a space for the expelling force to be directed on to it from behind.

If it be large enough to fill the entire calibre of the passage,

which is rarely the case, it will, before interfered with, probably lie loosely in the passage, its further entrance being arrested by the contraction of the wall.

In both these instances it is likely that efficient syringing will remove the intruder, without resort to any instrument. If, however, this is not the case, it is evident that the direction of any extracting or expelling force must depend on the portion of the canal in which it is applied, and also that, having in view secondary consequences, and the effect of inflammation in frustrating our efforts to remove a foreign body from the passage, we should employ no force that is in the least calculated to excite this. The greater the swelling of the wall of the meatus, the greater the jamming of the foreign body, whatever be its nature. If it be hard and angular this is more likely to occur.

If it be pushed into the pouch in front of the membrane, and the latter be contused in attempts to catch it, the more likely are we to have inflammation of the membrane and resulting perforation, with tympanic mischief. If the canal become so swollen that the foreign body cannot be seen, and its removal be still attempted, then the effects of this 'groping in the dark' are more disastrous; further inflammatory mischief and tighter jamming will result.

Perichondritis (Chondromalacia).—We have seen only a few cases of true perichondritis of the auricle. These occurred idiopathically, and not as the result of injury. The affection followed the usual course—general redness of the greater part of the auricle, obliteration of the normal sulci, an effusion of serous fluid, which rapidly became purulent. There was great pain and intense sensitiveness to the touch. After evacuation of the pus, keeping the opening patent with the local use of antiseptics, the swelling subsided, but in both cases there was a certain shrinking of the auricle, with consequent deformity. Such deformity is a common consequence of the affection. More particularly should it be left to run through its different stages without interference. Perichondritis has been mistaken for hæmatoma auris, from which affection it is, however, quite distinct; both clinically and pathologically.

To open either a hæmatoma or a perichondrial effusion we should first have the surface of the ear carefully washed with a soft shaving-brush with some antiseptic soap. It is then covered for some time with a pad of gauze which has been soaked in formalin solution 1 in 1,000. Finally, the entire ear is douched with absolute alcohol and perchloride of mercury (1 in 1,000), equal parts. The fluid is then aspirated with a sterilized needle, and compression is main-

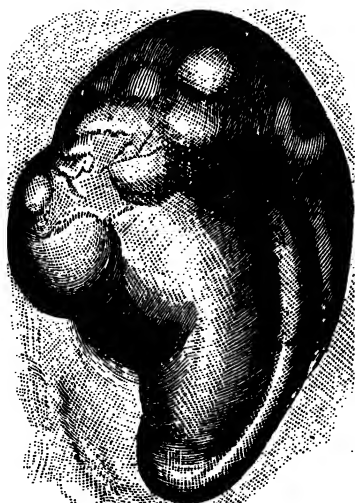


FIG. 83.—OTHÆMATOMA IN THE ACUTE OR PRIMARY STAGE
(RINGROSE ATKINS).

Tumour of extraordinary size occupying the entire cavity of the auricle, and obliterating its ridges and hollows. Surface uneven, and in parts of a plum colour. *Result*: slow absorption, with extreme contraction, and finally the almost complete distortion of the auricle and obliteration of its several component parts. Case of E. H., affected with active melancholia; taken from life.—²Macnaughton-Jones's 'Atlas of Diseases of the Ear.'

tained with sterilized iodoform gauze wrung out of formalin solution and covered with sterilized cotton-wool.

Othæmatoma,* or Blood Tumour in the Auricle.—
Othæmatoma, or sanguineous tumour of the external ear,

* For the original chapter on Othæmatoma in the second edition of this work we were indebted to the able psychologist, the late Ringrose Atkins, Resident Medical Superintendent of the Waterford Asylum.

may be either idiopathic or traumatic. In the former variety it is, with very rare exceptions, solely met with amongst those affected with mental disease; in the latter it frequently results from a direct blow, and is occasionally met with in the football field.

Nature and Appearance.—Othæmatoma consists of an effusion of blood from the perichondrium investing the cartilage of the auricle, appearing as a tense and shining tumour of a reddish-blue or livid colour, varying in size, and occupying some portion of the concavity of the organ, rarely forming on the posterior convex surface. When it commences in the concha, the tumour is generally localized above and externally by the ridge of the antihelix, and extends inwards towards the meatus externus, which it may occlude, causing deafness according to the degree of occlusion. In this situation the tumour presents itself as a smooth and usually even swelling, about as large as a pigeon's egg; when the fossa of the helix is the site of the effusion, it is confined below by the ridge of the antihelix, and the swelling then assumes a somewhat kidney-shaped outline.

In exceptional cases the tumour becomes extended over the entire surface of the auricle, and when this is the case the various ridges and cavities become wholly obliterated, the hollow of the ear being filled by an egg-shaped swelling, fuller above, and losing itself inferiorly in the lobule, which is never implicated.

These cases may be taken as examples of the so-called 'insane ear': In a woman suffering from active melancholia a hæmatoma appeared in the left ear, and in three days it had developed to a large globular tumour, filling the entire cavity, of a livid red colour, and completely obliterating the meatus. In two months it had commenced to shrink, and after six months the ear was quite shapeless and shrivelled. In the case of a male patient suffering from subacute mania, the entire cavity of the auricle was occupied by a large ovoid sanguineous swelling, without any known cause, in less than twenty-four hours. The ear in this case is now also shrunk, the upper part of the concha being thrown into several sinuous folds, the organ still, however, retaining its normal shape and gross outline.

Othæmatomata are accompanied by scarcely any subjective symptoms, but little pain or increased heat being experienced, any deafness that may exist being due to the mechanical

closure of the external meatus by the tumour. They frequently form very rapidly, instances of which have just been mentioned, but generally from a fortnight to three weeks elapse before they become fully developed. The contents are usually found to be purely sanguineous, though

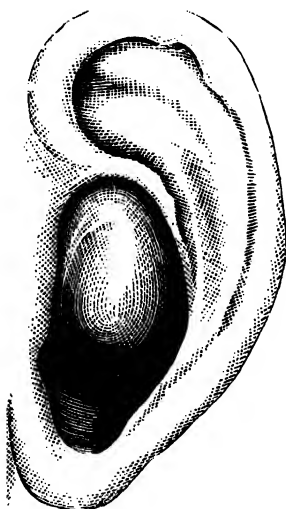


FIG. 84.—OTHÆMATOMA IN THE ACUTE OR PRIMARY STAGE (RINGROSE ATKINS).

Tumour of moderate size filling up the cavity of the concha; full and rounded above, where it is bounded by the ridge of the antihelix, being lost below in the lobule. *Result:* disappearance, with but little subsequent deformity. Case of C. H., affected with recurrent paroxysmal mania; taken from life.—Macnaughton-Jones's 'Atlas of Diseases of the Ear.'

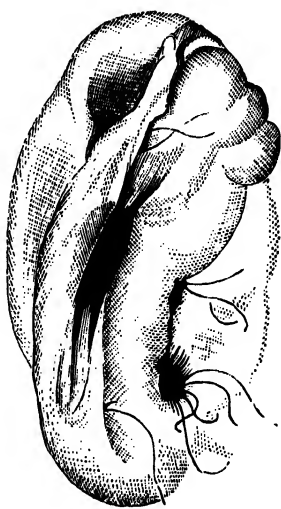


FIG. 85.—OTHÆMATOMA IN ADVANCED SECONDARY STAGE (RINGROSE ATKINS).

Helix folded over antihelix, fossa of latter completely obliterated. The upper portion of the auricle was transformed into an irregularly tuberculated, misshapen mass. On section, a triangular portion of bone had become developed in the centre, surrounded with cartilage and connective tissue. Affection of very long standing. Case of J. M., affected with chronic dementia; taken after death.—Macnaughton-Jones's 'Atlas of Diseases of the Ear.'

a yellowish serous fluid has been observed to escape on puncture; the contained blood remains fluid for a longer period than when extravasated elsewhere, but when evacuated shows a tendency towards normal coagulability. Suppuration sometimes occurs in the contents of the tumour, accom-

panied with the usual symptoms of heat, pain, etc., followed, perhaps, by rupture of the sac, if the latter be not surgically interfered with. In one such case lately under observation free incision afforded vent to a large quantity of sero-purulent fluid, but the tumour rapidly filled again, death taking place before further interference could be had recourse to, the case being one of far-advanced paralytic dementia.

The course of othæmatomata in many respects closely resembles that of blood extravasations occurring in other parts of the body. The tumour, in its ordinary condition, rarely bursts, though the skin may crack and some sanguineous oozing follow, usually at about the end of three weeks, or from that to a month. When the tumour has become fully developed, the effused blood slowly coagulates and gradually solidifies, and then what may be termed the secondary stage, or that of *shrivelling*, commences. As the watery portion of the blood is reabsorbed and the fibrin precipitated, the skin and cartilage become irregularly adherent to the cyst walls, and the latter contract unequally upon themselves. New fibrous tissue is then formed, which in time may become cartilaginous or even osseous; and, as the result of these changes, the affected surface of the auricle is distorted, and assumes the most bizarre and fantastic forms, which are henceforth permanent.

The hollow of the ear may be thrown into irregular folds or sinuosities; the helix folded over the concha, which may be greatly thickened, and frequently the entire organ becomes so crumpled and shapeless as to be barely recognisable.

Regarding the frequency with which either ear is affected, the left is the one most often attacked. In the majority of cases we have met with the affection has been bilateral, but in those unilaterally attacked the left side has the preponderance.

Etiology and Pathology.—The occurrence of othæmatoma was first noticed in Germany, but as an accompaniment of mental disturbance it was first studied in France by Ferrus in 1838. The result of his researches directed attention to the subject, and many important papers relating to it subsequently appeared from time to time, the most important being the 'Memoirs of M. Achille Foville,' published in 1859, and those of MM. Délassiauve and Motet, inserted in the *Gazette Hebdomadaire* in the same

year. In the year 1850 Franz Fischer directed attention to two forms of affection occurring in the ears of the insane. The one appeared as a 'serous œdema,' the other as a 'sanguineous tumour.' The first condition was frequently bilateral, colourless, and painless, rapidly forming and as rapidly disappearing. The second was unilateral, of a special colour, painful, and of longer duration. The contents were easily reproduced after an accidental puncture, and subsequent deformity of the ear ensued. Following these authors, M. Maury published a thesis on the subject, in which he gave a résumé of the various views which had been advanced as to the nature and origin of the tumours up to that time.

As to the etiology of the affection, various theories have been put forward from time to time to account for this peculiar occurrence. Yung and Senbuscher attributed them to passive hyperæmia of the neck and ear, with paralysis of the vascular nerves. According to Neumann, hæmatoma is an erysipelas of a particular kind. Schmaltz considered the affection to be the result of inflammation of the cartilage of the ear, and Fischer coincides in this view, attributing it to a chronic inflammation of the auricular cartilage and its envelope, to which is added a dyscrasia of a particular kind. It was looked upon by Renaudin as a serous œdema, a passive hæmorrhage, an active effusion, or the product of inflammatory action, according to the state of the affected individual, the nature of the malady, and the conditions which have preceded their appearance. 'They are produced,' says Merlan, 'most frequently in a spontaneous manner, sometimes under the influence of atmospheric variations, and sometimes as the result of traumatic causes.' Marcé, who published a case of double hæmatoma of the ear, in which the eyelids were also the seat of sanguineous effusion, believed that, under the influence of congestion, the vessels of the ear dilate, and that this condition determines or favours the production of hæmatoma.

Délassiauve, sharing the views of Renaudin, is of opinion that the hæmatoma must be in great part attributed to the textural peculiarity and special sensibility of the ear. Its proneness to become flushed under the least emotional disturbances or under the least physical injury, and its sudden pallor under other circumstances, combine to prove, says this author, that the ear participates more than one imagines in the conditions of general life. Foville, in the conclusions arrived at in the memoir already alluded to, thus expresses himself: 'The formation of sanguineous tumours of the auricle is most often preceded and accompanied by a general disturbance of the cephalic circulation.' Morel was also in favour of the theory of congestion with hæmorrhage. Ducros, in a memoir presented to the Faculty of Medicine at Montpellier, concluded 'that the causes of hæmatoma are multiple, but that traumaticisms alone never suffice to explain its occurrence; it appears that a local affection of the cartilage, depending on a disturbance of the nervous system, always pre-exists.'

Castelain, who has examined the question closely, thus expresses

himself: 'Under the influence of this profound disturbance of the economy, there occurs a *ramolissement* which plays a considerable part as a predisposing cause in the production of sanguineous tumours.' The opinion of Bonnet was that the sanguineous tumours of the ears are veritable congestive apoplexies due to degeneration of the sympathetic, which results in turgescence of the vessels of the ear, and, as a sequel, the apoplexy is produced. Griesinger leant to the hypothesis that traumatic causes were the most fruitful source of their origin, alleging that the tumours were not met with in asylums carefully looked after, and in which the attendants were active in their surveillance. If injury were commonly the cause, we should expect to find ecchymosis or abrasion of the skin, with damage to the auditory apparatus, which, so far as we are aware, never appears, nor do we meet with this result from blows on the ear of sane persons.

Nicol suggested that the sanguineous effusion is produced by the pressure of the delicate structure of the external ear against the mastoid process of the temporal bone during sleep by the pillow beneath—especially when the latter is hard—in a patient weakened by some 'blood dyscrasia.' Were this the cause, many more cases of othæmatoma must occur, as the great majority of patients who are likely to be its subjects lie on one or the other side, bear the same pressure, and suffer from the same blood dyscrasia, and yet hæmatoma occurs in but a small minority. Moreover, there is no reason to suppose that the pinna is so delicate and peculiar in structure. Robertson considers that othæmatoma is more probably due to functional disorder of the cervical sympathetic, associated with, or perhaps resulting from, the existing cerebral or cerebro-spinal disturbance, on the following data: (1) The tumour not unfrequently appears on both ears simultaneously, without any indication of either being injured; (2) an effusion under the conjunctiva occurred in a case of dementia at the same time and on the same side as the tumour of the ear; (3) some of its complications, such as Graves' disease, indicate disorder of the vaso-motor system. Whether such vaso-motor disturbance be the cause or not, there can be no doubt that mental excitement, resulting from derangement of the vascular system, is a very constant factor, its occurrence being most frequent in those forms of insanity in which such excitement runs high.

Five out of fifteen cases treated by Ringrose Atkins were discharged as cured; hence, though an unfavourable prognostic, we do not think the development of a hæmatoma should be looked upon as one of the physical characteristics of a hopeless lunatic.

Pathological Appearances.—The morbid appearances presented by the shrivelled ear differ according to the age of the formation. Barlow (*Glasgow Medical Journal*, July, 1875) found a section to be dark and fleshy in aspect, firm and slightly elastic in structure, and adhering closely

to the cartilage of the auricle, and less firmly, though with considerable tenacity, to the perichondrium. The tumour was a quarter of an inch in its thickest part; a transverse section, under a power of 300 diameters, showed it to be composed almost entirely of white fibrous tissue, with here and there collections of shrivelled blood corpuscles, the fibres being stained at these points with blood-pigment. The fibrous tissue was denser at the point of junction of the cartilage with the tumour than at any other point. One of the shrivelled ears which we examined, measured, on section, $1\frac{1}{8}$ inch in greatest thickness, and was dense and solid throughout. A fine section under the microscope showed it to consist of somewhat loose fibrous tissue, with deposits of fine hyaline cartilage, and a little within the centre a triangular-shaped mass of bone containing wide channels with lacunæ and canaliculi. The condition of the ears here, as we have mentioned, was of very long standing, and between this and the organized clot of the earlier stages we noticed fibrous tissue and cartilage in varying degrees of development.

Forms of Mental Disorder in which Othæmatoma occurs.—Othæmatoma is not confined to any one form of insanity; it has been found in mania, melancholia, and dementia, but it occurs most frequently in general paresis and insanity associated with epilepsy.

Treatment.—Gruber first suggested surgical treatment, recommending evacuation of the contents of the tumour and subsequent compression. In insane patients, however, in the great majority of cases, proper interference of this nature is impossible, and with them, as often in the case of others, such pressure cannot be applied to the ear as will prevent the refilling of the tumour, and the risk of consequent suppuration is great. Aspiration should be tried in the first instance, and repeated, if necessary, with all the precautions directed in the case of perichondritis. If the tumour be freely opened, the walls of the cavity having been well mopped out with sterilized gauze soaked in 5 per cent. of peroxide of hydrogen, it is well packed with iodoform gauze wet with formalin. Should necrosis have

occurred, curettage is indicated. The painting of the surface of the tumour with vesicating fluid has had a good effect in some cases, and the painting, both internally to the cyst wall and externally, with tincture of iodine is also recommended.

Acute Otitis Externa.—Diffuse inflammation of the external auditory canal of the acute type is induced by the same causes that contribute to produce the more circumscribed attack of furuncle or abscess. We find it also in association with sea-bathing, the exanthemata, the presence of foreign bodies, and imprudent attempts to extract them; the strumous diathesis, gout, syphilis, injuries, diabetes, otomycosis, and cholesteatomata. Diphtheritic inflammation of the canal is extremely rare.

Course and Symptoms.—The inflammation, once excited, spreads rapidly, and may extend from the dermal layer of the meatus to the periosteum of the osseous portion. The continuity of these structures with the tympanic membrane and cavity explains how in severe cases the osseous canal may become involved in the inflammation and necrosis or caries result, and how, more frequently still, the tympanic membrane and middle ear are attacked.

Thus the site of the inflammation, or its extent and limitation, influences its character and course. If the osseous canal be specially involved, there is greater pain, often complete occlusion, the subjective symptoms of deafness and tinnitus are intenser, the course of the disease is more tedious, the middle ear is more likely to be affected, and the hearing permanently influenced.

The local signs of diffuse inflammation are characteristic of it, and can hardly with care be mistaken for any other affection, save the more circumscribed form of abscess or boil. There are present from the first pain, sense of heat, throbbing, tinnitus, some deafness. On examination of the ear, there is, perhaps, some redness of the auricle, with general sensitiveness; the patient shrinks from the touch of the speculum; the ear-passage is swollen, the walls of the meatus are red, and appear to touch each other, preventing any view of the membrane. For some days there

may be no discharge, or only some sticky secretion closing the small aperture between the swollen walls. Then follows some discharge of serous, sero-sanguineous, or purulent secretion, generally mingled with débris of shed epidermis. Still the pain continues, recurring with fresh severity on each accession of the inflammation, and is aggravated at night. The pulse increases in frequency, the tongue becomes coated; there is loss of appetite, the disinclination for food being further increased by the pain experienced from the movement of the jaw in eating.

The progress of the disease and its subsequent course will in great measure depend on the local treatment the patient receives and the severity of the attack. Too frequently it is tedious, and runs into the chronic type of the affection, some swelling and erosion of the canal walls continuing, with purulent discharge and more or less involvement of the tympanic cavity, and possibly perforation of the membrane. In severe cases, occurring in delicate, ill-nourished children, extensive gangrenous sloughs may be formed, and these may even encroach upon the adjacent soft structures of the cheek, head, and neck.

Recurrences of the inflammation are apt to take place, causing a renewal of the symptoms. When the disease has pursued its course unchecked, there remains very often a granular state of the mucous lining of the meatus and tympanum, and small vascular granulations. The mastoid cells may be attacked, and inflammation spreading to these, mastoid abscess, caries, or necrosis may ensue, or in the worst cases meningitis, inflammation of the brain, and pyæmia.

Cholesteatoma of the Auditory Canal.—In certain forms of diffuse inflammation of the auditory canal in which the congestion with swelling extends deeply and widely, there is considerable desquamation of the epithelium. This epithelial proliferation is associated frequently with the development of vascular granulations, amounting in some instances to small polypi. The entire canal thus becomes filled with débris of epithelium, sebaceous secretion, and cerumen. *Pari passu* with these degenerative changes are periosteal and osseous

inflammatory degenerations, leading to suppuration with caries or necrosis of the bone. Should so serious a condition exist, it is difficult to determine whether the middle ear be affected primarily or not, as the proliferation of the epithelium and the cholesteatomatous invasion may have begun in the tympanic cavity or attic, and have spread to the external auditory canal. This difficulty is due not only to the blocking up of the canal by the inspissated mass, which may almost entirely fill it, but also to the thick and profuse sero-purulent discharge present. Associated with this invasion there is considerable swelling of the auricle, and generally of the mastoid as well as the parotid region.

Treatment.—In the acute form of otitis externa much that has been said of the treatment of furuncle and recurrent abscess applies. Its complications and consequences have to be dealt with in the manner indicated when discussing stenosis of the external auditory canal and suppurative otitis media. If we see the affection in its acute stages, early resort to leeches or to the artificial leech, the use of Leiter's irrigator, mild warm astringent and antiseptic douches, the use of such sedatives as cocaine, morphia, and atropine, anodyne fomentations, with the administration of saline aperients, assisted by a few small doses of calomel, will often cut the inflammation short and bring about early resolution. The patient should be kept at rest, the diet carefully attended to, and no alcohol permitted. The meatus should be daily examined, and any débris cautiously removed by douche, forceps, or wool-holder. Astringent applications should then be directly applied, and if there be protracted swelling or any reason to suspect the presence of pus, a free incision should be made into the swollen tissue. If there be otomycosis, this will demand special application, and should desquamative exfoliation exist with cholesteatoma, the masses will have to be gradually removed by warm aseptic douchings, the lever-ring forceps, and cotton-wool holder. In doing this, such antiseptics as peroxide of hydrogen, formalin, absolute alcohol, and boric acid, not using any of sufficient strength to cause irritation of the canal, but rather to assist by their

bactericidal properties, will materially help us. Personally, we do not much care for the insufflation of powders into the auditory canal, the best, however, being that of boric acid with aristol. Having cleansed the part as far as is possible at one sitting, we dry it carefully, and then make the antiseptic application with the aural probe and wool. A thin roll of iodoform gauze dipped in the antiseptic, or, if need be, the anodyne application, is carried with fine forceps to the bottom of the canal, and lightly packed into it. Before doing so, an application of nitrate of silver, ten grains to the ounce, is made with the aural probe to the inflamed surface. We have to be careful in the application of the stronger solutions which are used by some. A good combination to apply after cleansing the ear is a mixture of carbolic acid (fl.) ℥30, sol. hydro. naphthol ℥20, sol. acid. bor. sat., alcohol absol., āā ʒii. Should more serious complications and consequences result from the otitis, the use of the curette may be called for. Should this occur, however, the middle ear is generally involved, and we have to treat an otitis media in addition to the external ear affection. Dilute muriatic acid (1 part to 3 of water) may be applied with the aural probe to any isolated areas of necrosed bone. In all cases the state of the system has to be regulated, salines administered in the early stages, alteratives given at intervals, phenacetin or others of the coal-tar products for the reduction of temperature, and the relief of pain with quinine in fairly free doses when indicated.

Chronic Otitis Externa.—This is commonly the consequence of the acute disease. The concurrence of chronic otitis media and suppurative discharge from the middle ear with otitis externa explains why the latter trouble is so often confounded with the former in practice, and confused under the general terms 'otitis' and 'otorrhœa.'

In the chronic affection various conditions of the external meatus and middle ear are met with. There are collections of pus and epithelium in the canal, which is more or less contracted, sensitive, irritable, and denuded of its epidermis in parts. The tympanic membrane participates in the chronic inflammation, loses its lustre, is thickened and often

perforated. Other appearances are similar to those found in otitis media.

Treatment.—The termination of the disease depends in great measure on the early attention given to it and the treatment adopted. To arrest the inflammatory process, to subdue the acute symptoms, and prevent the extension of the mischief to the osseous tissue and the middle ear and ossicles are our main objects. If the inflammation extend to the mastoid cells or destroys the roof of the tympanum, then the case is of a most grave character. On the other hand, with early and judicious treatment and continued care of the ear, in the great majority of cases the patient recovers, if not perfectly, with but slight permanent results.

Furunculus and Abscess in the External Meatus.—

Both ordinary furunculus and more severe abscess may occur in persons of all ages and every type of constitution, and often in those who enjoy robust health, though various degrees of circumscribed inflammation are more commonly observed in those who from any cause are debilitated and enfeebled in general health.

Causation.—We find among the most common causes of abscess exposure to cold, injuries, irritation of the meatus from foreign bodies, ‘picking at’ the ear with the nail, pins, or other pointed bodies, and a collection of wax. In eczematous conditions of the meatus there is frequently considerable itchiness and irritation of the skin at the orifice. This leads to scratching of the part with the finger-nail and exposure of a raw surface, which becomes the seat of infection.

The association between the occurrence of furunculus and abscess and the season of the year, malaria, and the presence of bacteria, has been fully referred to.

Symptoms.—The symptoms are characteristic—severe pain in the ear of a shooting nature, increased at night, with some slight attendant fever and constitutional disturbance. There may be some deafness and tinnitus. The pain is of a radiating character, extending to the side of the head, and aggravated by movement of the jaw in eating. The entire ear becomes sensitive to the touch, the patient shrinks from

examination. The abscess may occupy any portion of the canal, and vary in size from a minute boil situated on some part of its wall to a considerable swelling which may block up the meatus. The intensity of the pain and the symptoms vary according to the situation and extent of the inflammation: whether it be restrained by the bony boundary of the canal, and in proximity to the membrane, or seated more externally in the cartilaginous portion.

Diagnosis.—The presence of the abscess is easily recognised. It is not often necessary to use any speculum, and

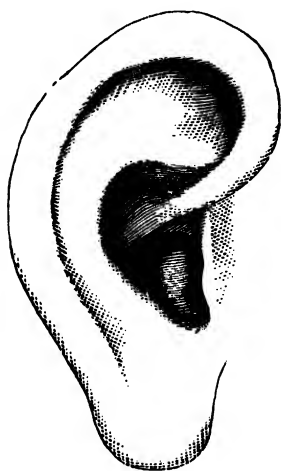


FIG. 86.—ABSCESS IN EXTERNAL MEATUS.

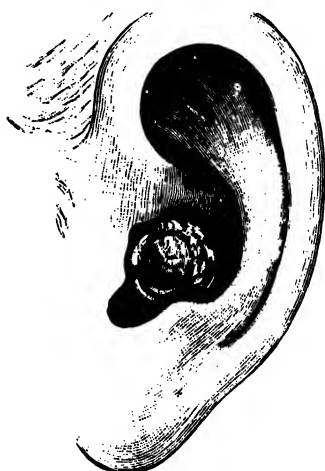


FIG. 87.—POLYPUS PROTRUDING FROM MEATUS.

this should be avoided if possible, as its employment causes unnecessary pain. This has given rise to an inexcusable source of error, one which, with any degree of care, should never be committed—namely, mistaking an abscess in its earlier stages for a polypus. The complete continuity of the abscess with the wall of the meatus immediately distinguishes it. It is rare for resolution to occur, and generally, in periods varying from two to six or eight days, pus forms and is discharged.

Treatment.—The treatment consists in depletion with leeches (two or four) applied over the tragus or in the

meatus, and in the early stage of the disease warm fomentations, such as a decoction of camomile and poppies and hot laudanum water, or the ear may be periodically steamed. The syphon douche can be used. A small conical poultice made of linseed meal in gauze, and dipped in some warm antiseptic (very weak formalin) solution, can be introduced into the meatus. Cocaine may be applied to relieve pain. Morphia given subcutaneously may be needful. A lanolated ointment of boric acid, morphia, cocaine, and atropine can be used with a camel's-hair pencil to the canal.

Poultices applied to the ear are dirty and dangerous. They are direct means of increasing microbiosis and of carrying organisms. With the pus, epithelium, and products of inflammation, they convert the auditory canal into a hothouse for the culture of bacteria. In fetid otorrhœal pus, schizomycetes, staphylococci and streptococci, spores and zoöglæa are found. And the facilities for transmission and migration which exist in the middle ear, with the internal ear, the petrous portion of the temporal bone, and the mastoid process, explain the presence of these organisms in fetid collections of pus and débris in these parts. Löwenberg thinks that those cases of cerebral abscess which occur without any breach of continuity in the petrous portion of the temporal bone are due to the penetration of the migrating corpuscles by the micrococci.

When the abscess has formed, an incision carried well into it is the only treatment, this incision being followed by careful antisepsis of the meatus and membrane. A small roll of sterilized iodoform gauze dipped in 1 in 3,000 of formalin solution is carried with a fine forceps into the canal. This is done after all particles of pus or blood have been gently removed by the aural wool - holder or the douche. This antiseptic roll is left in until the following day, when the canal is again dressed. If there be pain, an aseptic roll of gauze soaked in cocaine solution may be kept in the canal.

We must not be satisfied with the relief we give the patient with the first incision, but continue our care of the canal for some time subsequently, otherwise occlusion of the passage, with epithelium and discharge, perhaps a recurrent abscess, or the implication finally of the membrane, is most likely to follow. The canal should be well cleansed

daily with a mild astringent and disinfectant lotion, such as boric acid, sulpho-carbonate of zinc, borate of soda, weak bichloride of mercury, or chinosol (used warm), for several days.

It is better not to trust this treatment to the patient. After the meatus is washed out each day it should be gently dried with the absorbent wool, and then the walls lightly wiped with a saturated solution of boric acid in water and alcohol.

As abscesses are particularly likely to recur, it is well to warn the patient of this tendency, and so avoid the unpleasantness which sometimes arises from impatience at the prolonged nature of the inflammation. It is in these recurrent cases that the continuance of poulticing does such mischief, relaxing the parts, and maintaining a chronic state of congestion of the vessels.

Weber-Liel rightly insisted, in the case of abscess of the meatus, on early and free incision. Thus the morbid process is shortened. He recommended a spirit bath of alcohol and weak solution of bichloride of mercury in the commencement of the inflammation; the patient lies on the side, and the ear is filled with the alcohol. This has a hygrometric and anæsthetic effect. A 5 per cent. solution of carbolic acid (2 to 4 drops) is injected subcutaneously into the furunculus. This lessens the tension and pain. The alcohol bath is then used for one hour. The injection is repeated if necessary; only a fresh and pure solution of carbolic acid should be used. Pain is thereby arrested, the inflammatory process is cut short, and recurrence anticipated.

At times abscess in the meatus assumes very formidable proportions. This is particularly so in those cases where there is frequent recurrence of the abscess.

Polypi.—These, whether mucous or fibrous, are frequently met with in the auditory canal. The myxomatous variety is very rare. The growth is seen as a globular body filling the lumen of the canal. It is not sensitive to the touch of the probe, which can be carried completely round it. The size of the pedicle varies; occasionally it is so slender as to break off readily in syringing the ear. At times the growth is multiple, and we may find two or more filling the canal. They may occur in both ears. There is not infrequently

some discharge that occludes the polypus, and some periodical bleeding from the ear has been noticed. The tympanum is commonly involved, and the more usual site of the polypus is the tympanic cavity. Consequently, there is associated perforation of the drumhead with otitis media. It is this complication which renders a polypus in the meatus dangerous, as there may be accumulation of septic débris behind the growth when it blocks the canal, for which there is no exit. Being painless, the polypus is often neglected until serious intracranial symptoms draw attention to the ear.

Treatment.—This consists in efficient removal and subsequent treatment of the seat of the polypoid growth. (This is discussed in the chapter on the Middle Ear.)

Atresia of the Auditory Canal.—We have already referred to the closure of the canal which generally attends upon

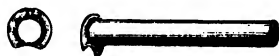


FIG. 88.—GILT TUBE FOR USE IN CASE OF ATRESIA AFTER OPERATION.

congenital malformations of the auricle. Such congenital closure is either of the osseous or membranous type. If the former, it is questionable whether any effort to improve the hearing be justifiable. In some cases there is a certain degree of hearing, despite the bony occlusion. If the atresia be due to the formation of granulation tissue and the growth of a fibrous wall which entirely occludes the canal to within a short distance from the orifice, the growth can be completely excised, and subsequent efforts, continued for some time, may enable us to keep the canal patent permanently.

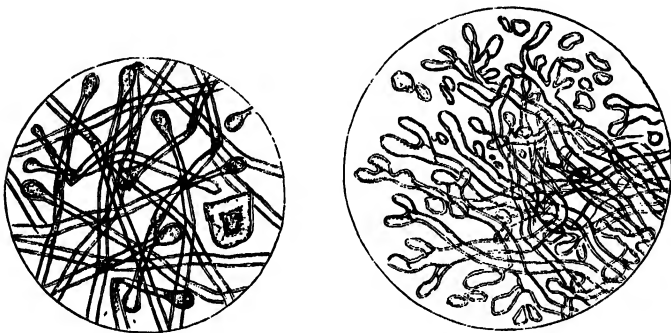
In a case under our care we have done this successfully with a silver-gilt tube. In this instance the surface of the new formation was covered with epithelium, and it almost reached to the orifice. We removed this, and found that it was backed behind by a thin osseous plate. This we also removed, and, exploring the cavity of the tympanum, found that the wall was bare. There was a history of otitis media with discharge in childhood. When the canal was patent, conversation could be heard well with this ear. The other ear had also been attacked, and the hearing was greatly impaired from chronic sclerotic changes in the tympanum. After a few secondary operations on the atresic canal to

keep it permanently patent, both with knife and cautery, the tube is now worn comfortably and all discharge has ceased. (This case was shown at the Otological Society by the author.)

Various plastic operations have been proposed for these conditions. Not much can be said for their success. Thiersch's method may be tried if the surface be sufficiently large.*

Otomycosis (*Aspergillus*).—*Etiology.*—To Burnett of Philadelphia we are specially indebted for the first clear description of the microscopic features of this fungus.

On the Continent many otologists, following Wreden and Mayer, described the etiology of otomycosis, more especially Pacini, Schwartze,



FIGS. 89, 90.—STAGES IN DEVELOPMENT OF *ASPERGILLUS NIGRICANS*—MYCELIAL WEBB AND FRUIT STALKS WITH BULBOUS ENDS (BURNETT).

Gruber, Politzer, Weber-Liel, Löwenberg. In America Orne Green and Roosa, and in England Cassells, added to our knowledge of these organisms. Burnett regards the *Aspergillus nigricans* as the commonest variety, and the *Aspergillus glaucus* as very rare. There is another variety, the *Aspergillus flavescens*. Many view these different varieties as only stages of development and examples of polymorphism. Löwenberg first described a cyst-like fungus which filled the canal, the bag containing mycelium, sporangia, free spores, and epidermis. The end of the cyst lies in some cases against the membrana tympani, of which it forms a cast. We have seen a typical sac of this nature leaving, on

* False membranes either congenital or the result of cicatrization are occasionally found either in front of the membrana tympani or of the cavity. Such membranous formations must be carefully excised with aseptic precautions. The presence of some membranous webbs is difficult to explain; we have seen some such that were not congenital, nor yet the result of cicatrization.

removal, a red and injected drumhead. Mayer and Pacini also described these formations.

In the etiology of otomycosis the favourable character of the external meatus for the growth of fungi and schizomycetes has to be remembered. The further tendency to otomycosis and the development of parasitical fungi is increased by the nature of the substances introduced into the meatus in the treatment of otitis (Löwenberg). In a great number of cases, he says, the affection is provoked by the introduction of an oily substance into the external ear, such as olive-oil, oil of almonds, etc., at times lard, balsam, or pomade. In employing these oily substances, it is not sufficiently remembered that they all undergo rapid decomposition once they remain exposed to the atmosphere, even at an ordinary temperature ; how much more so at the more elevated one of the auditory

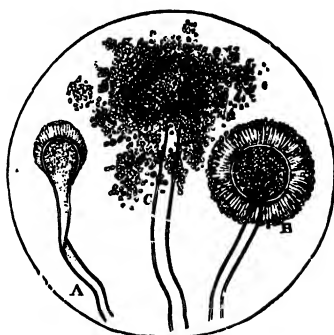


FIG. 91.—*ASPERGILLUS NIGRICANS* (BURNETT).

- A, Ovoid receptaculum, the lower fourth of which is free from sporangia ;
B, spherical receptaculum covered by sterigmata *aspergillus glaucus*.

meatus. Oils contain in solution azotic substances which, under the influence of the oxygen of the air, provoke special fermentation, becoming rancid. This raises the temperature rapidly ; the neutral fatty matters contained in the oil are changed into glycerine and fatty acids. Thus the spores of the musty fungi, which are abundant, are provided with all that is necessary for their germination—viz., oxygen, watery vapour (in the air), sufficient heat, organic decomposition, and the acidity which favours their development. The filaments of the mycelium grow rapidly. The acid products of the decomposition on the one hand, and the vegetable foreign body on the other, irritate the ear and set up this inflammatory process, causing the watery secretion, and exciting the formation of the organic azotic substances so easily assimilated by these cryptogams.

Also Löwenberg noticed that certain solutions in common use as lotions appeared to induce this fungus growth. On investigating the cause of this, he found an explanation in the presence of cloudy collections of

mycelia and spores that formed after those solutions were kept for a few days. We examined a large number of such solutions, and we kept these solutions in corked and open bottles. At intervals of from one week to a fortnight in all, whether opened or closed, quantities of spores were found, but far more in the open bottles. Some of the carbolized and the chloride of zinc solutions were quite free of spores; it was not so in others. Here we have a fruitful source of fungoid and other germs of infection, more especially in catarrhal conditions of the meatus and tympanum, attended by perforation of the membrane, while cerumen and aspergillus are not commonly found together. Particles of wool are often found mingled with the fungus. We have several times removed from the ear of a patient a mass of wool, the presence of which he was innocent of, when this had formed, with fatty matter, epithelium, and fungus, a complete plug, concealing a perforation, while the fungus flourished in the tympanic cavity. It is not a disease of the better classes, but it is not a matter for surprise that it is frequently met with in the poorer hospital patients. Here neglect, want of cleanliness, and general ill-health combine to produce it. At other times we have removed an amalgam of oil and dead epidermis coating the membrana tympani, and adhering to it like a cast.

Treatment.—Our knowledge of the causes predisposing to the growth of the fungus teaches us some important lessons in prophylaxis. In the treatment of inflammatory affections of the auditory canal and middle ear, to insure daily antiseptic treatment and prevent the use of fatty and oleaginous remedies by the patient; to impress on patients the need for great cleanliness of the ear-passage, as well as care in the renewal of lotions and the manner of using them, and to avoid picking at the ear with the finger-nail. In treating the fungus, we place reliance principally on alcohol and glycerine—equal parts of absolute alcohol and glycerine; this we apply after thorough cleansing of the part, whether meatus or tympanic cavities, with cotton-wool on the aural probe. We also use carbolic acid and glycerine (1 part to 2), and chromic acid (grs. xx. ad ʒi.); boric acid with absolute alcohol and water (saturated solution). The meatus and tympanum may be washed out daily with a bichloride of mercury lotion (1 in 1,000). Burnett speaks highly of solution of hyposulphite of soda (grs. iii. ad ʒi.). In cases where there is perforation of the membrane, the tympanum should be washed out thoroughly with a disinfectant solution by passing the stream through the nose in the manner already

described, or with the intra-tympanic douche. Fowler's solution has been used as a parasiticide (Turnbull), and chloride of lime (grs. ii. ad ʒi.—Wreden). The patient must be seen occasionally and for some time, as by this means alone can we be certain of a permanent cure.

How necessary it is to use sterilized water, or water that has been recently boiled, in syringing the ear when the tympanum is exposed, or if there be débris at the bottom of the canal, and that there is any communication with the tympanic cavity is shown by these facts. We see also how dangerous are these 'oil-drops' that are occasionally and aimlessly prescribed. Danger may be obviated by prescribing concentrated aseptic solutions in absolute alcohol and sterilized water, and ordering the patient to make his lotion by adding a certain amount of these to the proper quantity of recently-boiled water.

Symptomatology.—With mycosis which has lasted any time there is generally deafness, with some discharge from the meatus, and possibly tinnitus. There is pain of a recurrent nature, though this may be absent, while irritation and itchiness of the meatus are complained of. On examining the ear with the speculum, we may find the meatus narrowed by the intermittent inflammatory attacks, and experience some difficulty in inspecting the membrane. This difficulty is further increased by a mass which blocks up the passage and obscures the view. On examining closely, we see that this is not of the nature of wax. It has a lardaceous appearance, like wet paper, of a grayish-white colour; the plug is mixed with epithelium, or it appears as a round mass, and we may, on removing this with syringe or forceps, see distinctly the fungus either on the wall of the meatus, on the tympanum, in its crevices, or in the tympanic cavity if there be a perforation of the membrane. The discharge also is not of the character of ordinary catarrhal inflammation. It is thin and watery. There is with each attack of inflammation a renewal of the pain and a change in the character of the discharge. These flakes of membrane which adhere to the meatus and membrane can be peeled off, leaving an injected surface underneath, or sometimes the pellicle removed is dotted with brown spots

of the aspergillus, or a perfect coat of the meatus may be detached.

Hyperostosis.—Hyperostosis is a diffused inflammatory thickening, with general hyperplasia of the osseous portion of the meatus. It may occlude the auditory meatus, producing deafness and tinnitus, or cause retention of secretions in the auditory canal or tympanum.

Cause and Symptoms.—It is caused by the spread of an inflammatory condition to the bone, and may be produced by middle-ear disease, syphilis, or gout, by the irritation of an acid discharge, polypus, caries of adjacent bone, or by injuries. If any symptoms exist, they are those caused by a narrowing of the lumen of the meatus, deafness and tinnitus, or those produced by the penning up of purulent débris in the cavity of the tympanum.

Treatment.—In treating a case of hyperostosis, the attention must be directed to the cause, and all sources of irritation removed. It is remarkable, sometimes, how soon this bone-thickening will disappear on the removal of a polypus, or by simply keeping the meatus clean and free. If, after the removal of the sources of inflammation, it does not subside, the insertion of a small ivory bougie (Bonnafont) or a laminaria tent, or painting with iodine or nitrate of silver, should be tried. Great good can thus be effected by persevering in the treatment.

The question of operation with a hyperostosis will arise if serious consequences are threatened from the imprisonment of septic matter behind it, or that the swelling has associated with it inflammation of the mastoid with suppuration. It is only rarely that removal is called for by the resulting deafness alone. The hyperostosis may be dealt with in three ways: The first is by the drill. If this be used, the greatest care and caution must be exercised, and a steel guard has to be adapted to protect the tympanum, while the depth to which the burr is worked is carefully noted. Different burrs have to be employed for increasing the size of the opening. The second method is to turn the auricle well forwards, and make an incision posteriorly half a centimetre behind the auricle, carrying it down to the meatus. The incision reaches

from the upper margin of the auricle to below the meatus. When this latter is exposed, the periosteum is incised close to its upper border, and is separated, together with the cartilaginous meatus. The hyperostosis is now exposed by drawing the auricle and meatus well forwards, when the hyperostosis is removed with mallet and chisel. Bleeding must be arrested by small tampons of iodoform gauze. Peroxide of hydrogen of 10 to 20 per cent. volumetric strength, or the extract of the suprarenal capsule, may be used as hæmostatics if necessary. The periosteum is replaced and the cartilaginous meatus before the auricle is stitched. The meatus is then tamponed with iodoform gauze, and the entire ear covered with aseptic dressing. The third method is to do a Stacke's operation, and at the same time remove the hyperostosis.

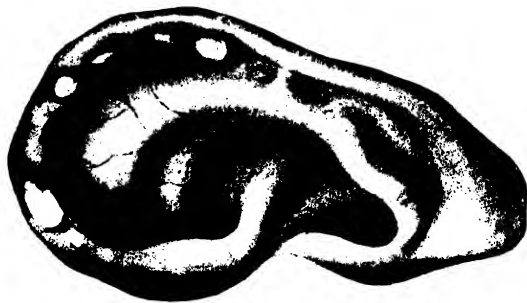
Exostosis. — Exostoses differ little from osteomatous growths in other parts of the body, and are commonly divided into spongy, ivory, and an intermediate variety, according to their degree of density. They are usually found growing at the junction of the cartilaginous and osseous portions of the canal. They may be caused by constitutional disturbances, such as gout or syphilis, by sea-bathing and much diving, or as one of the results of a neglected chronic middle-ear suppuration.

The *spongy* is a softish tumour, usually single, pedunculated, and of rapid growth. The variety may be produced by the conversion of a polypus into the osseous condition. It is easily removed with the snare.

The *ivory* is so named from its hard consistence. It grows slowly from a broad base; it may be single or multiple, is covered with a smooth white skin, and is usually seen on the posterior wall of the meatus. This condition seldom yields to any simple treatment, and, if it should cause deafness, removal is the only cure. In the intermediate variety the growth is less dense than the ivory, but harder than the spongy variety. It is often multiple, with a broad base, and the skin covering it is white. Here treatment by dilatation and astringent and absorbent applications is indicated.

The radical treatment of exostosis must be carried out

PLATE I.



GERMINATING GRASS-SEED, AS SEEN
THROUGH THE SPECULUM
(AUTHOR).

It was attached to the meatus in front
of the membrane, against which it
appeared translucent and of a pink
colour. (Drawn before removal by
Mrs. Taylor.)

EARS OF MALE PATIENT SUFFERING FROM GOUTY ARTHRITIS WITH OSSIFIC ENLARGEMENTS AND ARTICULAR
SWELLINGS (AUTHOR).

(Drawn by Mrs. Taylor.)

either by the drill and burr, with the precautions just insisted upon, or by deflection of the auricle and cartilaginous meatus, and removal with the mallet and chisel. Such operations are not called for unless there be such occlusion of the canal



FIG. 92.—EXOSTOSIS IN THE MEATUS ('Atlas of Diseases of the Membrana Tympani.'—Author).

as to cause deafness, or that the exostosis be of such a size as to prevent us dealing with inflammatory conditions which are behind it in the auditory canal or tympanum, and such cases are comparatively rare; otherwise, we consider that operative interference with these growths is wholly unjustifiable.

CHAPTER VIII

AFFECTIONS OF THE MIDDLE EAR

By W. R. H. STEWART

DISEASES of the middle ear include those of the membrana tympani, the cavity of the tympanum with its contents, and the Eustachian tubes. Statistics show that middle-ear disease is accountable for the largest number of cases that come under our observation; that over a third of the cases come under the heads of chronic middle-ear inflammation and Eustachian trouble; and that very nearly half the cases are made up of acute and chronic middle-ear suppuration. These statistics were worked out some years ago. They are, however, fully borne out by more recent experience. The majority of the cases of suppuration occur among hospital patients, and the worst are most frequently produced by neglect in the early stages. We may, therefore, truly say that a large number may be put down to preventable causes, or causes over which the controlling influences within the reach of every surgeon and physician can be exerted, so as either to prevent or minimize their pernicious effects.

Myringitis.

Inflammation of the Membrane—Myringitis.—Burnett says that myringitis is an inflammation of the dermoid layer of the drumhead, and there is no doubt that the dermoid layer of the membrane may be attacked with acute inflammation and yet the tympanic cavity itself escape. I do not look on an acute inflammation limited to the membrane as

of such extreme severity as many authors suppose. If this be not strictly true in an anatomical sense, it is as undoubtedly a matter of common clinical experience that inflammation of the external meatus spreads to the membrane, as it is that catarrhal conditions of the middle ear expend their force on it. Yet, independently of any previous external or middle-ear inflammation, patients now and again come under our care in whom inflammation—beginning in an injected state of the drumhead, running on to a general redness, these vascular changes being accompanied by severe intermittent shooting pain—has culminated in perforation, and has slowly subsided under treatment without any permanent effect on the hearing. Such inflammation results from sitting in a cold draught, or a blow of the fist on the ear, or, again, it may occur in connection with aspergillic inflammation of the canal. More frequently, however, we find the membrane inflamed after the occurrence of a small abscess in the external meatus, or inflammation attacking it in consequence of exposure to cold, or after catarrhal conditions of the throat and naso-pharynx in which the Eustachian tube and tympanum are involved.

Symptoms.—The delicate drumhead may be the first part to attract attention to the mischief by reason of the pain, tinnitus, and throbbing which usher in an attack.

In the early stages the patient usually complains of slight deafness and tinnitus in one or both ears. There is a dull periodical pain, increased if we stretch the auricle, exert pressure on the tragus, or insert the speculum. On examining the ear, we find the meatus near the membrane injected, and the membrane itself, with the manubrium, unusually vascular.

In the later stages the pain is more constant and severe, especially at night; the tinnitus is more marked, the patient frets and seems generally unwell, and the movement of the jaw in mastication gives pain. On examining the membrane, there is a full and bulged or flattened look. Perhaps the normal concave appearance is lost, and the whole membrane presents rather a convex surface, giving us the idea of concealed fluid in the drum cavity. The prognosis is

generally good, the inflammatory condition clearing up, and the hearing power being completely restored. A slight myringitis sometimes accompanies severe neuralgic pain on the side of the face.

Treatment.—In the treatment the main object is to arrest and limit the inflammatory process while we relieve the pain. Occasionally, notwithstanding any means that we employ, acute perforation will occur, or at least some superficial ulceration of the drumhead.

Patients who suffer from myringitis are usually out of sorts. There is some cause for worry, and usually there is a debilitated and relaxed state of the entire system. Under these circumstances, quinine in 5-grain doses by itself, or combined with iron, should be given, or liq. arsenicalis in 4-minim doses. Bromide of potassium in 20-grain doses, combined with hydrate of chloral, taken at regular intervals, is a good combination to assuage the pain. The local application of ethylic ether, or cocaine in the meatus, are of some service.

The best treatment, however, is hot lead and opium fomentations, as hot as can be borne, and the instillation of hot lead (grs. ii. ad ʒi.) and opium solution. These should be commenced as soon as possible, and applied every hour at first, and then at increasing intervals. A warm calamine lotion may be substituted for the lead and opium. Counter irritation in the shape of a mustard-leaf over the mastoid, and if the inflammation is severe and does not show signs of improvement leeches, from two to four, should be applied in front of the tragus, care being taken to occlude the meatus with cotton-wool. The bleeding should be encouraged with warm fomentation. Rest in bed, absolute and complete, both physical and mental, from the commencement of the attack, combined with a non-stimulating diet, conduces to a speedy cure. The throat should be carefully attended to, and the Eustachian tubes kept free. Great care and gentleness is required when inflating the tympanum, or damage may be caused. It is best to defer the inflation until the more acute stage has passed. Should there be fulness and bulging of the membrane, and we fear any accumulation in the tympanic cavity, paracentesis should be at once per-

formed. Change of air will be imperatively required should the attack become intermittent.

Paracentesis of the Tympanic Membrane.—It may be said that every surgeon who undertakes the care of aural cases, and anyone who presumes to treat deafness, or, indeed, to guide the aural complications met with in such acute diseases as scarlatina, the various fevers, or acute inflammatory throat affections, should be prepared to carry out this step safely and efficiently. It is not a difficult one, and the landmarks to guide us in its performance are clear and distinct. The safety and utility of this procedure, which Hinton so emphatically advocated in cases of catarrh of the tympanum, closed Eustachian tube, rigidity of the membrana tympani in various states, accompanied by obstinate and troublesome tinnitus in the acute suppurative catarrh of scarlatina, is undoubted, and one which can alone relieve certain morbid states causing or accompanying deafness.

In many cases of catarrh of the tympanum, accumulation of mucus with incurved membrane, incision is followed by results far exceeding our most sanguine expectations. At the same time we must be prepared for many negative trials and disappointments. The operation may be thus performed: The patient should be preferably in a sitting position, the head firmly supported by an assistant, and a good light thrown on the membrane through a wide speculum—Kramer's expanding or Stewart's self-retaining are perhaps the best. A small lance-shaped knife (Fig. 93) is carried steadily down to the membrane, and a cut made into the posterior inferior quadrant at the point of greatest bulging. There is but trifling bleeding, and very little pain. A small sharp-pointed bistoury, a tenotome, an abscess knife, or a sheathed myringotome may be found useful if the other is not forthcoming. The position of the chorda tympani and the ossicles should be borne in mind, and care taken not to injure them. Gentle Politzerization after the incision may be required to clear the cavity of the tympanum, care being taken not to injure the edges of the wound. The patient should also exercise caution after the operation, resting gently in bed, and avoiding cold and stimulating diet. After

perforating, it is sometimes useful to aspirate the tympanic cavity, and then thoroughly wash it out by means of the intra-tympanic syringe.* Owing to the great tendency there is for the incision to heal rapidly, it may be necessary to excise a piece of the membrane in order to insure patency. Except in the case of children and hysterical, nervous persons, no further anæsthetic than cocaine is necessary, and even in these cases gas is sufficient.

Cretaceous Deposits on the Membrane.—Often associated with catarrhal conditions of the tympanum we find these deposits (composed of phosphate of lime), which are easily recognised. They appear as white layers of a chalky

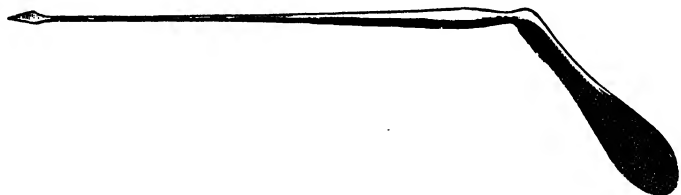


FIG. 93.—LANCE-SHAPED MYRINGOTOME.

substance, arranged crescentically near the periphery, or irregularly radiating towards the handle of the malleus. They usually occur in patients who have suffered from long-standing inflammatory disease, especially where there is a gouty diathesis. They are very troublesome at times, owing to the severe and persistent tinnitus they cause. Deafness may be slight or very great, and vertigo may also be present. They are usually unilateral. Non-interference is the best treatment; but should the tinnitus be excessive, then an attempt may be made to scrape away the substance with a small sharp spoon. If this is unsuccessful, the part must be excised. The same observations with regard to anæsthetics apply to these cases.

Perforation of the Drumhead.—This may be brought about by a variety of causes, among which the following are the most common: By an acute or chronic middle-ear

suppuration, or by an incision to relieve a distended tympanum; by irritating applications; by violent sneezing or coughing, as in whooping-cough; by atmospheric pressure, as the concussion from an explosion; working in caissons (no man should be allowed to go into an atmosphere in a state of compression unless he can prove by means of the Valsalvan process that the Eustachian tubes are patent); boxing the ears (rupture of the drumhead from this cause would form good grounds for an action in a court of law); diving; by direct violence, such as wounds caused by foreign bodies and the unskilled endeavours to remove them; the use of ear-picks, hairpins, etc.; by forcible syringing, and from pulling the auricle. Besides rupture of the drumhead, lesser injury, such as circumscribed hæmorrhage, may be produced by violent sneezing, coughing, too violent inflation, catheterization, the too energetic use of the masseur, or sudden changes of atmospheric pressure. It may also occur in certain infectious diseases, such as typhus, plague, etc.

The diagnosis is readily made, as a perforation, unless it presents the form of a mere rent or a minute pinhole in the membrane, is easily seen, and if not, can be discovered by means of the auscultation tube. A source of error to beginners is the bright bubble of air and liquid which sometimes obscures the orifice. On throwing a good light on the membrane, and desiring the patient to close the nose and blow, the air will often be seen to bubble out through the aperture. Sometimes these acute perforations pulsate; this is due to the arterial throb. This pulsation may puzzle a beginner not accustomed to examine such perforations. As to the character of the perforation, this may vary in size from a small pin-hole or chink to a large ragged opening. One or all the bones may be destroyed or attached by adhesions to the tympanic walls. A mere rim of membrane may be all that is left, or even this may be absent.

The prognosis is good if the perforation is small and recent, with clean margins. This is not so if it be large, with irregular edges, and if the suppuration has been considerable. It is remarkable the large number of patients who have extensive perforations, yet retain good hearing-power. The

greater the number of cases we treat, the more are we astonished at the percentage of patients whose hearing varies, say, from $\frac{5}{100}$ to $\frac{10}{100}$ with the watch test, and whose conversational power is excellent. As noticed by Politzer, Wilde, and others, this hearing-power does not appear to depend so much on the size of the perforation as the part implicated. It, of course, is more particularly influenced by an abnormality of the stapes if the bone be fixed by adhesions, ankylosis, or indirectly affected through the direction of the perforation (Politzer) and the transmission of the sound-waves to this bone. This has to be remembered in the application of artificial membranes, the good effected being not so much attributable to closure of the opening by the disc or wool as to properly applied pressure through the stapes.

Treatment.—First we must inquire carefully into the cause, and deal with this. If it be of recent occurrence, the aperture will probably close if perfect cleanliness and strict antiseptic precautions are observed. If not, the edges should be lightly touched with nitrate of silver, trichloroacetic acid, chromic acid, or a fine galvano-cautery point; and if the perforation is circular, a slight incision at either end will sometimes start the healing process. If ruptured from violence of any sort, care must be taken not to injure the wound when washing away a clot by too forcible syringing in order to avoid the thickened cicatrix, which is apt to result. Very large perforations heal over, and even where the membrane and ossicles have entirely disappeared fibrous tissue forms across and closes the cavity. As a counterbalancing result, however, we find that, though the cavity is protected, the little hearing-power that remains may be destroyed.

In some cases of perforation of the drumhead the application of an artificial membrane may be of service. Before doing so, there are some facts that must be remembered, both as regards the manner in which the false membrane acts and its mode of application. It does not improve the hearing by merely closing the opening; on the contrary, closure frequently acts the reverse way. The artificial disc may improve the hearing by changing the leverage pressure

of the ossicular chain, and then altering the pressure on the fluid of the labyrinth.

The pressure on either the malleus or incus is distributed through the stapes to the labyrinth, or it may be directly to the stapes. The direction of the applied pressure must vary in different positions or conditions of the ossicles dependent on the amount of destruction or displacement which has occurred. Knapp points out how diminution of tension may follow from the pressure of the artificial membrane on the short process of the malleus, which, if pressed inwards, would release the lower arm and move the stapes outwards. Thus it comes to pass that in some cases where no aperture in the membrane exists, the pressure of the artificial disc improves the hearing by acting on the equilibration of the fluid in the labyrinth. Thus, also, we see why it is that the results which follow from its use are so variable, and how necessary it is to try patiently and perseveringly to ascertain whether it improves the hearing or not by altering the direction of the pressure. This experiment may have to be repeated a few times. It follows equally that we must seek for other causes of disturbance of equilibration than the ossicular in the application of an artificial membrane, and, if possible, remove these—as, for example, any obstruction in the Eustachian tube. The improvement in hearing is sometimes extremely marked, and the delight of the patient who suddenly hears conversation is in proportion. Other possible consequences than the increase in hearing-power must, however, be remembered in connection with the use of the membrane, be it made of rubber or wool.

It may be said that these only follow from the careless or improper application or use of the membrane, yet, as they do so follow, it is well to bear them in mind. The disc may cause pain and irritation in the ear if it be too long or too forcibly applied. It may also produce giddiness. It may bring about septic states of the meatus and middle ear if worn too constantly, if it be not removed at night, or if the ear is not systematically cleansed during its use, and attention paid to the periodical disinfection of the ear passage. If these precautions be taken to obviate such consequences, and

patients are given precise instructions, no harm is likely to follow the use of the membrane.

Of late years, for hospital practice, we have seldom resorted to any membrane save when there was marked improvement; but we must say that, in our experience, in a large percentage of perforation cases improvement is not sufficient to compensate for the inconvenience and risk that attends the

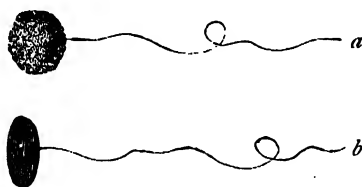


FIG. 94.—*a*, YEARSLEY'S COTTON-WOOL; *b*, GRUBER'S MEMBRANE.

use of the artificial membrane in the poorer classes of society, where neglect of it is often found to be followed by bad results. It is better in such persons to get the drum cavity and perforation into as healthy a state as possible, enforcing on the patients a periodical visit, and unless they are very



FIG. 95.—FORCEPS FOR APPLYING YEARSLEY'S WOOL, WITH TUBE FOR CARRYING MEMBRANE.

intelligent we do not trust them with an artificial membrane.

The figures represent some different forms of artificial membranes. In practice it will be found that the best results are to be obtained from the ball of absorbent wool or the plain rubber disc. We generally find that where metal is used irritation ensues; we have known the rubber disc adhere to margins of the perforation. Before the membrane is applied with a small forceps or by its stem, the ear must be cleansed and disinfected, the disc or wool having been first moistened with carbolized glycerine or solution of

bichloride of mercury in glycerine, strength 1 in 3,000, or, better still, a weak formalin solution.

It is best to remove all artificial membranes at night. We would, however, emphasize the fact that cotton-wool are the safest artificial drumheads and the best.

Inflammation of the Middle Ear.

Trötsch originally divided middle-ear inflammation into simple acute and simple chronic, these being subdivided into dry and moist, acute suppurative and chronic suppurative.

The following are the views of Weber-Liel on the etiology of simple catarrh of the tympanum : (1) There arises from the paralysis of the tensor veli collapse of the walls of the Eustachian tube, and therefore hindrance of the proper ventilation of the tympanic cavity ; (2) Allowing that the tensor veli acts as an antagonistic to the tensor tympani, when the elastic strain and contractility of the tensor veli is entirely or partially paralyzed, not only collapse of the tube occurs, but an antagonistic contraction of the tensor tympani also ; and so, the want of air in the tympanic cavity being added to the effect of the anomalous straining of the powerful system of active factors in the mechanism of the tympanic cavity, a high degree of nutritive and functional anomaly in the cavity and labyrinth must in time be occasioned.

He classifies the causes of aural catarrh as follows : (1) Extension of a simple catarrh from the Eustachian tube and the naso-pharyngeal cavity ; (2) collapse of the walls of the Eustachian canal, dependent on insufficient or paralyzed action of the Eustachian tube muscles ; (3) alterations of the vaso-motor and trophic nerves supplying the tympanic cavity.

Thus arise many cases of catarrh of the middle ear, from the hyperæmia *ex vacuo*, caused by the rarefaction of the intra-tympanic air, and the retardation of the tympanic and the intra-tympanic circulation by the increased amount of strain and limited motion of the structures from the abnormally contracted tensor tympani. This double effect of air in the cavity and contraction of the tensor tympani cause (1) an abnormally strong tension of the tympanic membrane, (2) an abnormally tight fixation of the chain of ossicles, and (3) an increase of the intra-labyrinthic pressure, since the stapes is pressed into the labyrinth by the ossicular chain. Thus the reception and conduction of the vibrations and the vibrating capability of the implicated portions are much prejudiced. As the functional expressions of these disturbances arise subjective auditory sensations, and frequently sensations of faintness.

At the beginning of the affection disturbances of hearing may seldom be present, or they are not then noticed as

deafness, but rather as acoustic hyperæsthesia for certain noises; and gradually defects in the capability of hearing, especially during mixed conversation, make their appearance, and again are followed by symptoms which are spoken of as 'accommodative disturbances,' and now, when the other ear begins to suffer, the tinnitus gradually arises and increases. For a long time there is nothing save singing noises in one ear, one being always first affected, the other following after some time.

The collapse of tubal walls and the abnormal contraction of the tensor tympani continuing, there develop in time secondary changes in the sound-conveying apparatus. The hyperæmia of the tympanic cavity already present often increases through the passage of catarrhal conditions from the pharynx to the now easily-affected parts, and intra-tympanic exudations are easily produced by slight attacks of cold. The structures in the tympanic cavity being, through defective equilibration, approximated to each other, afford these exudations points for adhesive attachments. A not necessary but very frequent consequence of the continual impressing and fast fixing of the stapes in the fenestra ovalis is a synostosis of the stapes and other anomalies in the joints of the ossicles, the local hyperæmia, which is especially marked in individuals of the gouty, rheumatic, and syphilitic diatheses, playing an important part in the production of such changes. In time the hyperæmia of the tympanic cavity lessens, the *stanungs-hyperæmie* leads to interstitial connective-tissue growth, and wasting of the vessels and trophic changes of different kinds are seen, atrophy of the tympanic membrane being common. It is comprehensible that in time changes in the circulation and nutrition of the labyrinth must also occur, not only on account of the continual and increasing pressure from the cavity, but on account of the difficulties under which the conducting apparatus must act.

It is a matter of observation that such patients at the beginning of a conversation often hear moderately well, but when the affected ear has been strained for an hour or so they complain of giddiness and increased tinnitus (spasmodic

contraction of the tensor tympani), which symptoms can only be referred to an increased flow of blood to the labyrinth. Pulmonic and hepatic congestion increase (through the connection of the labyrinth with the arachnoidal space through the ductus cochlea) this trouble.

The snapping noises heard, even by bystanders, in certain catarrhal states are accounted for by the separation of the moist walls of the Eustachian tube in swallowing.

Weber-Liel still adheres strongly to these views on the subject of aural catarrh. He does not regard pharyngeal catarrh as such a direct cause of aural mischief as some would insist. In most of those cases of aural catarrh, he is of opinion that the accompanying difficulties in singing, swallowing, or in inflating by Politzer's method are due rather to a collapse of the tube-walls 'through the abolition of the counter-straining force of the antagonistic muscles'—it is not a catarrhal state, it is rather paretic—'we can pass a bougie when the air-douche will not act.'

Eustachian Collapse, Obstruction, and Closure.

Most frequently the origin of both acute and chronic (non-suppurative) catarrh may be traced to some abnormal state of the Eustachian tube. The study of the various diseases of the ear which follow its abnormal conditions shows that the healthy or unhealthy state of this passage offers to us a clue to the causes of by far the largest proportion of aural complaints.

Causes.—The exciting causes of Eustachian closure may be simply cold 'caught' in any way; exposure to draughts, damp, rheumatism, sea-bathing, exanthemata, mental shocks, diphtheritic paralysis, etc., are some of the most frequently assigned. During a cold everyone is familiar with the sense of stuffing in the ears, likened by many patients to the feel of cotton-wool in the meatus, and the muffling of sounds, or the tinnitus, which occasionally accompanies it. On examining the throat, we may find the mucous membrane swollen or turgid; there may be a granular state of the pharyngeal membrane, the follicles are enlarged, perhaps

the uvula is relaxed, or the tonsils are hypertrophied. The faucial orifice of the Eustachian tube is likewise swollen, and in consequence there is temporary closure of the passage and an imprisonment of the secretions therein. When this condition persists for a time, we see the characteristic dull membrane of Eustachian closure. Little air enters the tube, and the air in the tympanum is rarefied; this results in an increased concavity of the membrane. In the earlier stages the drumhead is retracted, without loss of colour; in the later stages it becomes dull, white, opaque, and retracted. The short process and the anterior and posterior folds are very prominent, and the handle of the malleus is more or less foreshortened. The usual triangular reflection is altered in appearance and situation, or is altogether absent. When inflation is resorted to, the auscultation-tube gives either a muffled sound or none is heard. This simple swelling of the Eustachian tube, beginning with a slight deafness and perhaps a little earache, which at first is periodical and remittent, becomes in time chronic and permanent. The length of time that will elapse before troublesome deafness, accompanied by tinnitus, occurs varies considerably, and is dependent to a certain extent on the mischief attacking only one or both ears.

Nothing in the whole range of medical practice is more astonishing than the extent to which persons permit aural mischief to proceed before they seek relief, the more so if only one ear be affected; and it is often the incessant tinnitus that forces them to apply, and not the deafness. The prognosis must, therefore, be guarded. If early advice is sought, a large amount of good may be done. If, however, the disease has lasted many years, the patient may, after prolonged and constant treatment, obtain some slight improvement. It may only be possible to keep the disease stationary, or, despite all our efforts, it may become gradually worse.

We may thus summarize the ordinary effects of Eustachian collapse and closure: Slight catarrhal inflammation, which is the consequence of the primary affection, leads to an accumulation of mucus. This mucus increases in quantity,

and is imprisoned. It may become hardened, and form hard masses both in the tube and the cavity of the tympanum, about the chain of ossicles and on the membrane. A chronically collapsed and closed Eustachian tube, leading to imprisonment of mucus and alterations in the position and structure of the membrana tympani, followed later on by permanent change in the shape and appearance of the latter, with adhesions, ankylosis of the ossicles, and hardening of the mucus, are the usual effects which ensue on a common cause—viz., an unhealthy state of the entire naso-pharyngeal mucous membrane.

Weber-Liel thus summarized the causes which contribute to relaxation, insufficient action, and paralysis of the tubal muscles and velum palati :

General weakly conditions from disease, parturition, excessive exertion, unhealthy conditions of life (nervous exhaustion, masturbation), will have disturbing influences on muscles already weak, and this is often the case with the muscular apparatus of the tube. The muscles of the tube of the left side participate in the general more feeble development of that side, and hence the affection nearly always begins on the left side. Chronic catarrh of the mucous membrane covering the muscles appears to have often been the starting-point of defective functional ability of this group of muscles. In nervous individuals, in those who are deeply affected by any grief or anxiety, in the presence of various nervous lesions (*e.g.*, of the trigeminus) the innervation of this portion is very easily disturbed under predisposing influences. Rheumatism, tubercle, typhus, diphtheritis, progressive muscular atrophy, chlorosis, and anæmia are amongst the commoner predisposing causes.

Treatment consists in inflations by Politzer's method, passing the Eustachian catheter and bôugie, washing out the tympanic cavity with an iodide of potassium, alkaline, or chloride of ammonium wash; the injection of paroline or liquid vaseline; the use of Valsalvan inhalation of guaiacum, iodine and ether or pine-oil (patients should be warned not to use Valsalvan inflation except under medical supervision, undue relaxation of the membrane and interference with the audition of the labyrinth following its too frequent use); the regular use of a sea-salt or alkaline nose-wash, with astringent applications to the pharynx and fauces. The application of galvanism to the tubal muscles sometimes does good. Constitutional

treatment must not be forgotten, and tonics administered. If there is narrowing of the Eustachian tube, due to chronic catarrh, Eustachian bougies should be passed. •

Simple Acute Catarrh.

Course and Features.—We find that the various forms of catarrh above enumerated are the result of different degrees of inflammatory action occurring in the tympanic cavity or the passages. The inflammation occurs most frequently in children. Both ears are at times equally affected, but, as a rule, the inflammation is more active on one side than the other.

Cause and Symptoms.—Simple catarrhal inflammation, when acute, may be caused by colds, exposure to draughts, wet feet, and acute diseases, such as the exanthemata, fevers, pneumonia, and diphtheria; sea-bathing, particularly in the surf, when minute irritating particles of debris penetrate the nasal passages and lodge in the tympanic cavity; collections of fluid in the tympanum, the passage of blood in epistaxis when the anterior nares have been plugged, foreign bodies passed by the Eustachian tube, blows on the ear, injuries to the membrane, sewer gas, malarial conditions (otitis intermittens of Weber-Liel), epidemic influenza, excessive smoking and alcohol drinking, the too free application of the galvano-cautery to the nasal passages, or severe operations on the nose.

Simple acute inflammation seldom causes a perforation of the drumhead.

In the milder form there is the advent of the slight deafness; the pain is trifling, rather in many cases described as an ‘uncomfortable feeling about the ear,’ some tinnitus—both the deafness and tinnitus following a sore throat—a slight attack of tonsillitis or nasal catarrh, perhaps some headache or pain in the ear in coughing, sneezing, or swallowing, and at times in talking, is present.

But in the more severe form all these symptoms are much intensified; the pain is severe and deep in the ear, and radiates over the side of the head. There may be great

tenderness over the mastoid; in the external meatus, and on pressing over the tragus, a sensation of fulness and weight is felt in the ear, and patients complain that their own voice has a peculiar hollow sound. Constitutional disturbance is greatly increased, the face becomes flushed and the skin hot, the pulse is quickened and the temperature rises; very young children become restless, crying out, the hand is carried to the affected ear, and they refuse to lie on that side. On examining the drumhead, we may perceive little alteration from its normal condition, it being but slightly injected. On the other hand, there may be great redness and injection of the vessels. The prominent full and red appearance of the membrane is characteristic. If secretion rapidly occurs, the pockets may be bulged out by the imprisoned mucus.

During an attack of acute inflammation violent pain may be complained of and a feeling experienced 'as if something had given way,' followed by hæmorrhage through a perforated membrane. Roosa has given the name of otitis hæmorrhagica to this form.

It should be borne in mind that pain referred to the ear may be caused by carious teeth, and whenever earache is present without sufficient objective symptoms to account for its cause the teeth should be examined.

Bacteriology.—Netter of Paris considers that there are four different forms of acute middle-ear inflammation, each having a special microbe.

1. Due to the pyogenic streptococcus of Netter, Zaufal, Moos, and Holst.
2. Due to the pneumococcus of Fränkel, Netter, Zaufal, and others.
3. Due to the pneumo-bacillus of Friedländer and Zaufal.
4. Due to the pyæmic staphylococcus of Fränkel, Simmonds, Róhrer, and Netter. †

That form caused by the pyogenic streptococcus is most frequent, and is more often found in the more serious cases which threaten life.

Acute middle-ear inflammation occurring in an otherwise healthy individual in consequence of a cold is greatly influenced by the pneumo-bacillus of Friedländer and the diplococcus of Fränkel and Weichselbaum.

All pathogenic microbes found in acute middle-ear inflammation are to be found in the nose, mouth, and pharynx of healthy subjects, and find

their way through the Eustachian tubes, thus necessitating strict anti-septic care in these cavities during the progress of an exanthem. The mechanism of the Eustachian tube is sufficient in a perfectly normal condition to stop the passage of germs. It is, however, seldom in such a perfect state.

Prognosis is generally favourable. The disease may, however, run on to suppuration, or to a thickening of the tympanic mucous membrane, a hardening of the mucus, or to adhesions causing ankylosis of the ossicles.

Treatment.—Hot lead and opium fomentations, with counter-irritation over the mastoid by means of a mustard-leaf or the liq. epispasticus. The former is preferable, as it is not necessary to vesicate unless the inflammation is very acute. In the latter case free leeching (two to four leeches) should be used, and applied in front of the tragus. It is important when using leeches to see that the external meatus is occluded with cotton-wool. Gentle inflation may be tried to remove collection of mucus and prevent adhesions forming; the strictest caution must be employed in doing this, in order to prevent damage to the inflamed drumhead and cavity. As the case improves, guaiacol, pine-oil or benzoinol inhalations by Valsalvan process may be given. A warm saline or alkaline nose-wash should be employed to thoroughly douche the naso-pharynx. The fauces must be attended to; febrile conditions met by salines and diaphoretics and a non-stimulating diet; alcohol and tobacco must be strictly prohibited. If there should at any time be any bulging of the drumhead, paracentesis should be performed to evacuate any effusion that may have collected. During convalescence the tympanic cavity can be washed out with a warm alkaline solution, and paroline injected.

Simple Chronic Catarrh.

A simple chronic catarrh may follow an acute attack. We, however, more frequently find it arise from injuries, the irritation of growths in the naso-pharynx, or to a more or less slow process of inflammation going on in the tympanic cavity initiated by Eustachian closure or collapse. The atrophic condition of the drumhead sometimes seen in these

cases is due to the upsetting of the balance of aerial equilibrium by Eustachian closure, the constant outside pressure tending to thin the membrane.

Symptoms.—The patient presents himself with a history of recent cold and earache, or he may complain of a sore throat which has been followed by a slight deafness and tinnitus, generally unilateral. On testing the hearing with a tuning-fork, we find that it is heard loudest in the affected ear, and that there is no marked difference on closing the meatus on this side; there may be a moist or gurgling sound heard through the auscultation-tube. The membrane will be found to have lost its transparency, is concave, and of a dull or grayish-white colour. Here we may at once suspect a recent acute attack, which is passing into a chronic condition, with accumulation of mucus in the tympanum. Typically this is a case in which prompt treatment is demanded. Unfortunately, however, the cases that more frequently come under our care are those that have been neglected and allowed to go on for years without treatment. In these the deafness, at first slight, has been gradually and almost imperceptibly increasing. There is usually an entire absence of pain. The throat and naso-pharynx have got into a chronic condition of irritation, dryness, and discomfort, or there may be a sense of fulness aggravated by atmospheric dampness. Tinnitus and vertigo may be altogether absent. Tinnitus, however, is usually present in the later stages, and both may be severe and persisting. Such sclerotic conditions are those for which, unfortunately, we are consulted when there is little good to be effected by any treatment.

In cases of accumulated mucus there is, in the appearance of the membrane, no one form characteristic of this condition. It may bulge forwards in any part or appear as if the entire membrane is pushed outwards, or, on the other hand, may appear abnormally concave. Most frequently, however, we find it concave; the handle of the malleus is retracted, the short process and anterior and posterior folds are prominent, and the usual tympanic reflection is broken up or altogether absent. The translucent look is lost; it is of a dull whitish colour, with patchy opacities, or cretaceous deposits may

appear. Mobility is usually impaired by adhesions, ankylosis of the ossicles, or obstruction of their movements by a collection of mucus or a swollen condition of the mucous membrane. Atrophic patches appear as dark spots, or are so transparent that the parts behind can be distinctly seen. The diagnosis of these patches can be easily confirmed by using the pneumatic speculum.

There is also a form of dry catarrh of the middle ear which occurs principally in middle life in syphilitic, gouty, or rheumatic patients. In these cases the Eustachian tubes are patent; the naso-pharynx and drumhead are normal in appearance. The deafness is steadily progressive, and there is usually tinnitus. The stapes seems to be the part usually affected, being immovably fixed by adhesions.

There can be no doubt that nerve impairment frequently attends on the presence of mucus in the tympanum.

The *prognosis* is decidedly unfavourable in the worst cases. In the majority there is no improvement, but under appropriate and constant treatment the disease may be arrested, and no further loss of hearing take place. In those very deaf patients that tell us they hear better amidst the rattle of omnibus and train the prognosis is still worse.

Treatment.—Poltzer's inflation two or three times a week, Valsalvan inhalations of guaiacum or iodine, the regular passing of the Eustachian catheter and bougie,* and washing out of the cavity of the tympanum with zinc sulphate (grs. v. ad ʒi.), iodide of potassium (grs. v. ad ʒi.), a weak alkaline wash, a 1 per cent. injection of pilocarpine, followed by injections of paroleine or liquid vaseline; astringent application should be made to the throat and naso-pharynx; enlarged tonsils should be amputated, and adenoid growths removed; a warm alkaline or sea-salt nose-douche should also be employed. In those cases in which the tinnitus becomes unbearable and the deafness is considerable, ossiculotomy should be performed, and sometimes has a very beneficial effect, relieving the tinnitus and at times improving the hearing.

The methodical practice of gymnastic exercises, by anti-

* See pp. 103-105.

septic gargling, of the muscles of deglutition and respiration and of the Eustachian tube, should be advised, while we combat the general debility by such means as a sea voyage, residence in a mountain climate, a tonic regimen, and the internal administration of the salts of iron, strychnine, quinine, etc.

In the treatment of all conditions supervening on a closed state of the Eustachian tube, the first matter is to secure its patency. The method of doing this we have already dwelt on—catheterization, assisted, if necessary, by celluloid or gum-elastic bougies,* about half a line to a line in diameter for the narrowest part of the Eustachian tube. The bougie is passed through the catheter, and the catheter is withdrawn before the bougie. The danger of fracture of the bougie



FIG. 96.—DELSTANCHE'S MASSEUR.

must be remembered. After the bougie is withdrawn, the tympanum is well inflated.

Suction of the Meatus will be found of service in collapsed conditions of the Eustachian tube. This is best effected with the pneumatic speculum;† through which we can at the same time see the extent of the adhesion.

Massage of the Tympanum has been highly recommended, and certainly does a great deal of good in cases where the ossicular chain has become rigid. In the majority the hearing is improved and the tinnitus relieved, and in a large number of cases vertiginous symptoms are removed. Ordinarily, Delstanché's masseur answers every purpose, but if the electric current is obtainable it ought to be used. It is very important that the vibrations should be regular and

* See Fig. 55, p. 104. '

† See Fig. 37, p. 91.

uniform, and this naturally is much more easily effected by electricity. It is also important that the vibrations should not be too violent. With ordinary precaution no ill effects follow. For the systemic states accompanying the tympanic trouble, perchloride of iron in combination with strychnia, where there is general debility, is a most valuable combination. At times, in hysterical patients and delicate women, bromide of potassium, or bromide of ammonium with iron, or the salts of zinc, bromide and phosphide, will be found most useful.

For the tinnitus, the internal use of bromide of potassium and hydrobromic acid, hydrobromic ether, and the nitrite of amyl may be tried. Iodide of potassium in gouty and syphilitic systems, and bichloride of mercury in the latter, are of service. Thorough cleaning out of the Eustachian tube and tympanum, combined with such internal remedies as give tone to the system, at the same time that we keep the secretions regular (with the use of such waters as Rubinat, Friedrichshall, Victoria, and Hunyadi Janos), is a summary of the treatment of mucous accumulations in the tympanum.

We have elsewhere alluded to the question of artificial perforation of the membrane and the mode of performing the operation. Whatever doubt may remain as to the propriety of this step as an experimental effort in obscure cases of deafness, especially when complicated with troublesome tinnitus, combined at times with division of the tensor tympani, none can exist as to its utility where accumulated and imprisoned secretion is ascertained to be the cause of the trouble, or in those acute cases, before referred to, which are so ambiguously grouped under the heading of 'acute aural catarrh,' and in which the pent-up secretion is prone to assume the suppurative character.

For example, a patient comes for treatment extremely deaf, not hearing the watch when pressed to the ear, and whose conversational hearing-power is very bad. The tuning-fork is well heard, but closure of the meatus produces no difference; the membrane has a bulged appearance, and the sound with the auscultation-tube is of a gurgling character. Incision is determined on, and accordingly, after some previous syringing with warm iodide of potassium, both membranes are punctured and the apertures kept free. A quantity of semi-transparent mucus of a brownish colour comes away through both openings.

This patient subsequently hears conversation in a low tone at several feet.

In rheumatic otitis media, turpentine and salicylate of soda are indicated, Weber-Liel speaking very highly of the former remedy.

Acute Suppurative Catarrh.

Causes.—There can be no doubt that the exanthemata are the most frequent causes of the disease. Cold, exposure to draughts, blows on the ear, the vile habit of 'boxing the ear'—any of the causes enumerated as operating in myringitis and simple acute catarrh—may originate the mischief.

Sunstroke is said to be a cause of the trouble, but this, I believe, is rare.

Symptoms.—There is more or less deafness, a sensation of fulness and throbbing in the ear. Tinnitus and vertigo may also be present. The pain, deep-seated and violent, is very severe. There is no pain more unbearable than that caused by an inflamed and distended tympanum. Fever ensues, and is frequently ushered in by a rigor. Double or exaggerated hearing may be present. Epileptic fits and vomiting may occur. The skin of the meatus is more or less hyperæmic, and if we examine the drumhead we find in the early stages a slight convexity, with signs of hyperæmia in the more vascular parts. Later on it gradually loses all its normal features and becomes more or less swollen, with bulgings in Shrapnell's membrane, and in the posterior and inferior quadrants. After perforation has occurred, the pain, as a rule, at once subsides. This is not always the case; pain may continue intense, with a distinct pulsation in the perforation. It must be recollected that acute suppuration may occur without perforation, the discharge escaping through the Eustachian tube.

Prognosis.—If the case is seen in the earlier stages, the prognosis is very favourable, the perforation in a healthy membrane healing rapidly, if not large, as soon as the acute inflammation has subsided. In the more severe forms, and in cases that have been neglected, the inflammatory condition may have wrought such havoc with the tympanic

contents that the hearing is irretrievably destroyed. The inflammation may also become chronic, and the patient is then exposed to any of the complications of the disease, or the cranial contents may be more rapidly attacked by the spread of the acute inflammation, and fatal results may quickly follow. Such an unfortunate complication is more frequently the result of an acute attack occurring in a case of chronic suppuration. It should be borne in mind that young children may become deaf mutes if the ears during the course of this disease are neglected.

Treatment.—In treating these cases, the seriousness of an attack should at no time be underrated. The patient should be kept in bed in a quiet room free from every kind of worry or work. Warm anodyne fomentations should be applied externally; counter-irritation over the mastoid in the form of a small portion of a mustard-leaf, and the free application of leeches in front of the tragus if the attack does not easily yield. The membrane should be incised to let out pent-up pus or secretion. If there be swelling, or other signs pointing to mastoid inflammation, a free incision over the process, or the opening up of the cells, will be necessary. When inflammation has ceased, the cavity of the tympanum should be washed out through the Eustachian catheter with a weak alkaline solution, and paroleine injected. The meatus must also be kept clean and free from pus by the instillation of a warm solution of peroxide of hydrogen, or a spray of a warm solution of enzymol, followed by a warm boric acid wash. At the same time the constitutional symptoms should be attended to, the bowels carefully relieved, and a saline given internally, while a combination of bromide of potassium and hydrate of chloral, or the subcutaneous injection of morphia, may relieve pain.

Chronic Suppurative Catarrh of the Middle Ear.

This affection may follow as a result of the acute form. Suppurative catarrh, acute or chronic, is often shamefully neglected, more especially in children; the younger the child, and therefore the less competent to make its complaint

known, the greater the probability of neglect. Aural mischief is, in a very young child, often masked by symptoms that direct attention to the other parts, the brain, stomach, or the teeth. Discharge from the ear is long neglected, and the ignorance of its cause or the results of its continuance induce many to fancy that to arrest it is a mistake; therefore it is that in children where there are obscure head symptoms, with feverishness and restlessness, the surgeon should always examine the ear. The carrying of the hand to the ear is often the only indication of any local mischief. Otorrhœa continues often for a long time in children with but little effect on the hearing, and no pain. When the ear is seen for the first time there is frequently perforation of the membrane, a granular state of it, or polypus. Too often it unfortunately happens that the surgeon is asked for advice only when irremediable and fatal brain complications have arisen. If this be culpable on the part of friends, how much more so is it in the case of the medical adviser, who, through carelessness, has permitted these warnings to pass unheeded, which might, if noticed in time, have saved life.

The absurd popular prejudice regarding discharges from the ear often leads to neglect. Thus, when the child is seen the otorrhœal discharge fills the meatus, blocks up the canal, and obscures the tympanum. The ossicles may have been destroyed, and long since escaped through the perforated membrane, and yet the patient is not brought for relief until the unpleasant odour renders it inconvenient for teacher or parent. Too frequently has the disease made inroads into the labyrinth or attacked the nerve. The tympanic cavity has cakes of old hardened masses of epithelium and pus, with the aspergillus fungus that has developed in the decaying débris. These are of all cases the most insidiously dangerous. Perhaps the discharge has ceased to flow from the meatus in consequence of the complete blocking-up of the tympanum, or the closure of a perforation, or the collection of cerumen in the external auditory canal. Meanwhile, mischief has been advancing in the petrous portion of the temporal and the adjacent surfaces of the brain membranes. Any form of brain trouble may be the consequence.

There cannot be the least doubt that the existence of a chronic otorrhœa should invalidate a life insurance, and that the concealment of such a condition, or any chronic disease of the ear, should cause the question to be raised of the *bonâ-fide* nature of an insurance contract.

The following is a classification of the causes of a chronic suppuration of the middle ear :

Diathesis	{ Gout. (Rare.) Struma (tubercle). (Frequent.)
	{ Primary syphilis. (Rare.) Inherited syphilis. (Occasional.) Fevers. (Exceptional.) Phthisis. (Occasional.)
General diseases	{ Exanthemata. (Frequent.) Diphtheria. (Occasional.) Mumps. (Occasional.) Angina Ludovici. (Rare.) Whooping-cough. (Not infrequent.)
Parotitis.	
Tonsillitis.	
Naso-pharyngeal adenoids.	
Naso-pharyngeal catarrh (acute and chronic).	
Ozæna.	
Catarrhal inflammation of the Eustachian tube.	
Other unhealthy throat states.	
	{ Injuries inflicted from the direction of the external meatus.
	{ Injuries inflicted from the direction of the Eustachian tube.
Traumatic	{ Puncture or rupture of the membrana tympani. Direct injury to the tympanic cavity. Injuries inflicted with the Eustachian catheter. Foreign bodies: (1) approaching from the Eustachian tube; (2) approaching from the external meatus.
	{ Injections through the Eustachian tube.
	{ Residence in the tropics. Temperature, dust, sand. Rainfall and moisture.
Climate and hygienic	{ Miasmatic influences. Sewer-gas. Defective drainage. Gas leakage. Epidemic influences.

Symptoms.—The symptoms vary considerably. A discharge, more or less constant and profuse, of a pale and watery consistence—occasionally stained with blood—or a thick and creamy one; it may be inodorous, but more frequently, and especially in long-standing cases, there is a smell varying from a slight unpleasantness to a decided stench. Pain is sometimes severe; in other cases, especially in the instance of strumous or phthisical children, there is none. Deafness from impaired aerial conduction; tinnitus and vertigo, due either to irritation or pressure; tenderness over the mastoid region; loss of taste from the chorda tympani being involved, facial paralysis from the portio dura being implicated, and epileptiform attacks may occur. The membrane ranges in colour from a pale pink to a deep red; the translucent appearance is usually lost, and the cone of light has disappeared or is displaced. Signs of old cicatrices and deposits of cretaceous matter may be visible. A perforation varying in size from a pin's point to complete destruction of the membrane is seen; in the latter case the objects on the internal wall of the tympanum may be observed. The tympanic mucous membrane may, however, be so swollen and œdematous as to mask them and resemble a polypus. Caries or necrosed bone is easily demonstrated if within reach of a probe. If it cannot be reached, the character and odour of the discharge may give some indication of its presence; but this test is not infallible, as a collection of putrid caseous pus and débris in the mastoid antrum will give rise to a most fetid smell.

A very large amount of disease is frequently found focussed in the upper region of the tympanic cavity, usually called the attic. The delicately constituted ossicles, feebly supplied with blood, readily fall victims to the inflammatory attack, and we often find that the cause of a continued discharge is due to the necrosis of one or more of them. Again, the chronic discharge, thin and evil smelling, may be, and frequently is, due to an antrum stuffed full of foetid pus which cannot be removed, the discharge from the meatus being simply an overflow.

Prognosis.—The prognosis must be very guarded. We

frequently get the very best results, the perforation healing, and the hearing-power being almost entirely restored. But the hearing may be permanently impaired, and the suppurative process may have so damaged the tympanic membrane and contents that complete and permanent deafness remains.

Treatment.—It is essential in treating these cases that extreme cleanliness and antiseptic precautions be employed to remove the discharge and inspissated pus, and to destroy any pathogenic microbes that may be present. The tympanum can be thoroughly washed out through the perforation in the manner already described. A warm alkaline wash is the best to use through the Eustachian catheter, or it may be washed out with the intra-tympanic syringe. A good plan of treatment is to thoroughly wash out the tympanic cavity with a warm boric acid solution, and then a warm solution of peroxide of hydrogen should be instilled and allowed to remain in for a quarter of an hour. If there is pus, a fizzing sound is heard. The cavity of the tympanum is again washed out with warm boric acid solution, and then a lotion composed of boric acid grs. xx., rectified spirit ℥i., is instilled, and should be allowed to remain in for ten minutes. This is used two or three times in the day. All lotions should be warmed before using. This we have found a most successful method of treatment. A spray of warm enzymol (Fairchild) is recommended for getting rid of the pus.

Another plan is to wash out with an acid perchloride solution; then, after careful drying with absorbent wool, to pack the meatus with iodoform gauze, carefully putting it in piece by piece; or, again, the cavity having been carefully cleansed out with a very weak (1 in 5,000) formalin solution, it is touched with a little mop of cotton-wool dipped in a solution of acid. carbolic. min. xxx., sol. hydronaphthol. min. xx., sat. sol. acid boric. ℥ii., absolute alcohol ℥iv.; then the cavity is packed with a strip of sterilized iodoform gauze, which is left for twenty-four hours, and the dressing again is renewed. This must be done by the surgeon himself. It is as well to use the air douche through the Eustachian tube while the washing is

going on, to drive the discharge into the meatus. Astringent solutions and powders, such as boric acid, orthoform, resorcin, tannic acid, salicylic acid, nitrate of silver, chloride of zinc, sulphate of zinc, absolute alcohol and glycerine, carbolic acid and glycerine, aldehyde, with carbolic acid, iodoform emulsion, sulphurous acid (1 in 8), if there is carious bone, have been frequently used with success.

After well washing out the meatus and perforation, the latter should be thoroughly dried with cotton-wool rolled on the aural holder,* and then, with the latter, nitrate of silver should be carried well to the margins of the perforation. If powders are used, they must be very gently blown in through a fine tube, and quite on to the surface of the membrane. There is, however, a strong objection to give

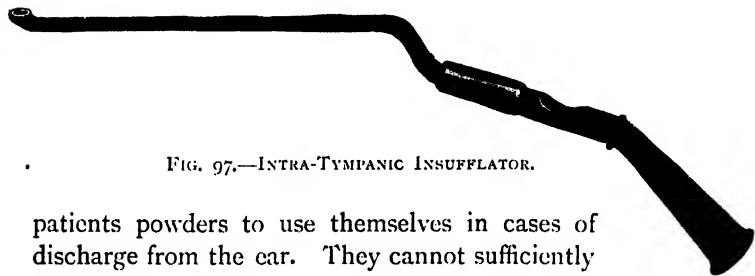


FIG. 97.—INTRA-TYMPANIC INSUFFLATOR.

patients powders to use themselves in cases of discharge from the ear. They cannot sufficiently cleanse the meatus when using them, and the powder is apt to cake both on the membrane and in the tympanum if there be a large perforation. The edges of the perforation may be touched with the solid nitrate of silver or a fine galvano-cautery point to assist the healing process. The swollen mucous membrane in the tympanum should be touched with the solid nitrate of silver, the finest cautery point, or the crystals of chromic acid. For the relief of pain, leeching in front of the tragus and counter-irritation over the mastoid should be used. In cases of caries with granulations, the whole cavity of the tympanum may have to be curetted out, and where the ossicles are involved these must be removed.

The great secret of successful treatment of chronic otorrhœa is constant attention and cleanliness on the part

* See Fig. 64, p. 108.

of the patient, combined with the almost daily attention by the surgeon himself. Tonics, cod-liver oil, maltine, iodide of potassium, in combination with strychnine or tartarated iron, should be given when necessary. Plenty of fresh air, with change of climate if possible. Try, however, how we may, there are some cases that resist all treatment; the foetor continues, and tenderness over the mastoid may or may not be present. In these cases delay is extremely dangerous, and the mastoid operation should at once be performed.

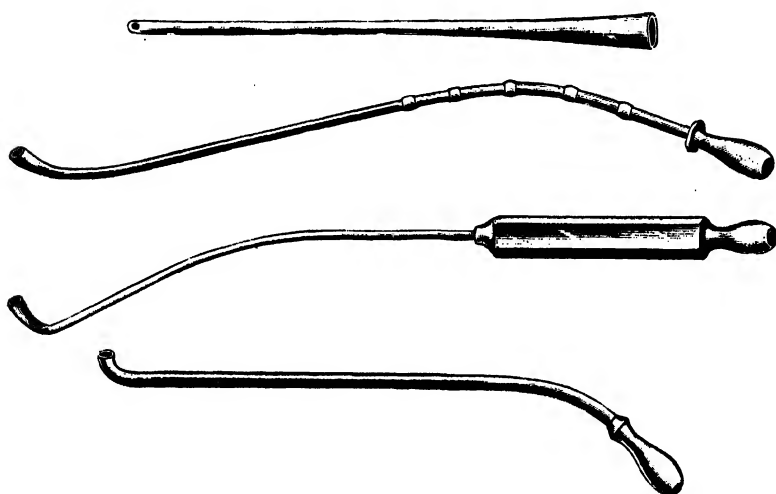


FIG. 98.—TYMPANIC AND ATTIC CANNULA FOR INTRA-TYMPANIC DOUCHING.

It should always be remembered that intra-cranial complications most frequently supervene in cases of chronic otorrhœa in which a fresh acute attack has supervened. Patients should therefore be warned cautiously, and without creating undue alarm, of the serious risk entailed. When the focus of suppuration is more or less confined to the attic, a way must be opened up through the membrana flaccida, and a portion of the bony ring may have to be removed in order to insure thorough drainage and to apply the necessary remedies. Fine cutting forceps and a rectangular knife are required for this purpose. The space should be thoroughly washed out with an intra-tympanic syringe.

Removal of the Membrane and Ossicles.

Schwartz first attempted to remove the entire drumhead in 1873, Kessel in 1878, but the rapid regrowth of the membrane rendered success but temporary. Later on, the latter removed the posterior part of the cartilaginous ring, and had much better success. As far back as the

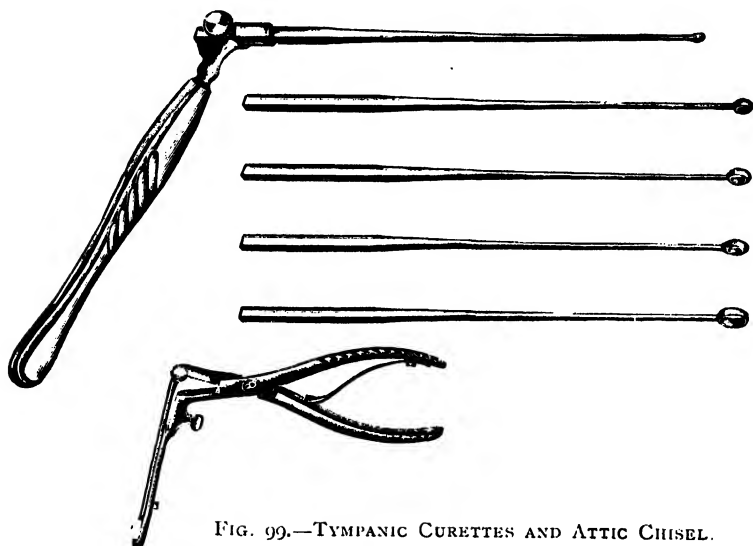


FIG. 99.—TYMPANIC CURETTES AND ATTIC CHISEL.

International Medical Congress of 1881, Lucæ, in a paper which he read, quoted twenty-five cases of entire removal of the membrane and ossicles. In none of these was there any deterioration of the hearing-power, and in some there was distinct improvement.

The following are indications for the operation :

1. Chronic purulent inflammation of the middle ear with caries of the ossicles.
2. Cholesteatomata of tympanum.
3. Fixation of malleus.
4. Great impairment in the function of the transmitting mechanism, with chronic catarrh of the tympanum.
5. Patients who cannot distinguish words spoken in a loud tone at 2 feet distance may generally be benefited.
6. In progressive deafness the progress is often arrested.
7. Vertigo and tinnitus are usually relieved, frequently entirely cured.

8. When it is impossible to open the Eustachian tube, and the hearing is improved by an incision into the retracted membrane.

When operating, the patient should be put deeply under an anæsthetic. The head should be firmly held by an assistant, and the auricle pulled upwards, backwards, and outwards. Should the membrane be much retracted, inflation of the tympanum may sometimes be a help. The membrane should be transfixed near the short process posteriorly with a trowel-shaped knife; a blunt pointed one is then inserted, and the membrane divided round the margin of the tympanic ring, a good portion of the cartilaginous ring being removed with it. The anterior portion is then dealt with in the same way. The joint between the incus and stapes must now be divided with an angular knife, and an endeavour made to bring away the incus with forceps. The malleus must now be freed from its attachments, and by gentle traction gradually brought away with the detached membrane. The blood must be cleared away from time to time with a small tampon of cotton-wool on a probe. The application of a solution of suprarenal capsular extract greatly diminishes the amount of hæmorrhage. Be careful not to seize the malleus near the umbo, or it may be broken. It is sometimes difficult to remove the incus on account of its displacement, it becoming lodged behind the tympanic ring above. After the operation, gentle cleaning is necessary, syringing being avoided unless absolutely required. Hot water usually stanches the bleeding, and pain may be relieved by cocaine. Inflammation of the parts generally follows the operation, and the consequent otorrhœa may last some time.

Complications of Chronic Middle-Ear Suppuration.

Of the complications that follow a chronic middle-ear suppuration, some are liable in a more or less degree to destroy the hearing-power, but are not, unless neglected, especially dangerous to life; others are most serious, and threaten the life of the patient. Two very common consequences are an *ulcerative condition* of the auricle and the

formation of adhesions and cicatricial bands, by which the remains of the membrane are bound down to the tympanic walls. The former is easily cured by cleanliness, by soaking away all crusts with carbolized oil, and then dusting the surface with iodoform, the points of deeper ulceration being touched by the solid nitrate of silver, if necessary. The latter, if too firm to be divided by Politzerization or by suction through a Siegle's speculum, may be divided by section of a portion of the band; but as this is a very delicate

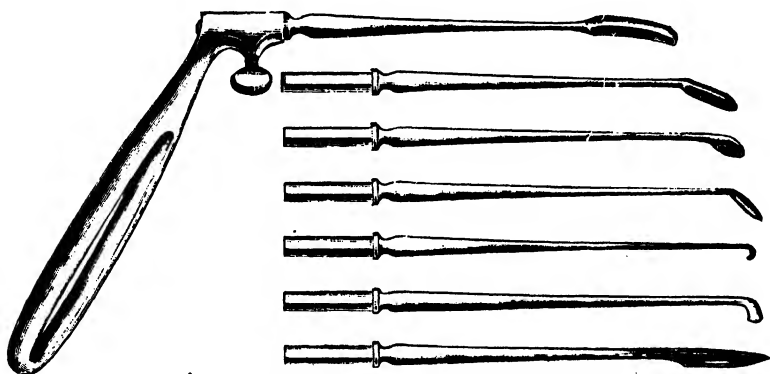


FIG. 100.—VARIOUS KNIVES, CURETTES, AND HOOKS FOR OSSICULOTOMY.

operation, and one the results of which are by no means certain, it is not to be lightly undertaken.

Malignant Disease.

Malignant disease, in the form of either epithelioma or sarcoma, occasionally attacks the middle ear. It usually occurs in patients suffering from a chronic suppurative middle-ear inflammation, the otorrhœa being followed by granulations and fungoid masses, which bleed freely when removed and rapidly recur. The glands are affected, and the facial nerves often implicated. The diagnosis between this and caries is very difficult at first; rapidly recurring growths should, however, at once be put under the microscope for examination.

No treatment is of much avail. If, however, the case is seen early and diagnosed, free removal should be attempted.

Polypi.

Polypi are found growing from the meatus, more especially its upper and inner walls, the tympanum, and the membrane.

Pathology.—They are either mucous, fibrous, or myxomatous. The first-named are composed mainly of a homogeneous stroma, in which are round, spindle and stellate cells enclosed in a fibrous framework. In their interior may be found cystic spaces lined with epithelium. They are rich in vessels. The density of the growth depends on its gradual conversion of the round cells into fibrous elements. The fibrillar nature of the fibrous polypus distinguishes it, and it is not so vascular as the mucous. True myxomatous polypi are exceedingly rare.

Those polypi which grow from the membrane and tympanic cavity are very vascular and sensitive to the touch. They occur as the result of otitis media and chronic suppurative states of the middle ear. They vary in size from a large mass, which completely fills the meatus and protrudes from it, to a small growth, which it is difficult to seize with the forceps.

Polypi may be single and unilateral or multiple, several existing in one ear, or we may find them in both ears. There is often a considerable discharge of pus, which is usually offensive, obscuring the growth, and which requires removal by a syringe before the polypus comes into view. Pain is not, as a rule, present in simple cases; if, however, obstruction to the outlet of pus is caused, great pain and tenderness soon sets in. The characteristic symptoms are deafness with a discharge, which is occasionally mingled with blood. Those springing from the deeper portion of the meatus, or just in front of the membrane, frequently conceal a perforation of the latter. *Prognosis* must be guarded, for until the polypus has been removed we cannot tell how far the middle ear is involved; unless properly treated they are very likely to recur.

Treatment.—Before operating, it is well to determine as carefully as possible the size, mobility, and seat of attachment of the polypus. This, as a rule, can be readily done with a

probe. Most of the globular polypi which fill up the meatus are easily removed with the ordinary small angular ring forceps, care being taken to grasp the tumour as near the root as possible. When using a snare of any kind, the only difficulty which we meet with is the careful noosing of the polypus close to its attachment. This, however, is seldom much trouble. The wire must be of proper strength and consistence, and at the same time such that it can be easily moulded so as to encircle the mass.

Fine copper or iron wire, if the growth is large and hard, is preferable. Thin wire or fishing gimp can be used in ordinary cases.

For operating on small vascular growths, either the rectangular ring-forceps, the lever ring-forceps,* or the ring-knife† is the best to use.

Free syringing will bring away any loose portions of polypus not removed by the forceps.

Hæmorrhage is generally very slight, a little hot water and hazeline serving to control any bleeding that may occur. If it proves troublesome, the extract of suprarenal capsule or peroxide of hydrogen, 5 per cent., will arrest it. It is not always possible to remove the whole of one of these vascular polypi at one sitting, and we have to operate three or four times before the growth is cleanly extirpated; the operation has to be done gently, and under a good light. But the mere removal of these troublesome growths is only the first step in the process of cure. It requires often considerable forbearance on the part both of the patient and surgeon to follow up the treatment. Periodical touching of the exposed surface with some caustic is required, as well as the thorough cleansing out of the canal. Having wiped the raw surface with cotton-wool, used on a probe, the site of the polypus must be lightly touched with a fine pencil of wool rolled on the point of the probe, and moistened with trichloroacetic acid. The crystallized acid is readily converted into a fluid state by the addition of a little water. We may also use nitrate of silver, carbolic acid, chromic acid, or perchloride of iron. One rule should be adopted in every case: no one

* See Fig. 66, p. 109.

† See Fig. 101, p. 187.

should be satisfied as to the cure of the disease until all discharge has ceased, and the surface from which the polypus has sprung presents a healthy appearance.

The injection of a few drops of liq. ferri perchlor., or pure alcohol, into the growth has been recommended when removal is objected to, and Grüber has successfully employed electrolysis; but actual removal, as advised, is the best course to follow. The neglect of polypi may lead to most serious consequences. The fatal results that have followed should act as a warning to practitioners not to simply pull away a polypus with a forceps or snare, and then send the patient home with the idea that he is cured, only giving him some simple lotion to keep the ear clean with. The growth returns, perhaps the patient has it again torn away, or partially torn, as happens in many cases, and he may think it useless to apply for relief for that which is certain to return, and so he is satisfied to let things remain as they are until some formidable symptoms are induced by new growth and discharge. This is the result of want of attention to the remains of the pedicle of the polypus or the granulations that form after its removal.

Whenever a polypus is removed, the patient should have impressed on him the necessity of a prolonged attendance or an occasional inspection of the ear subsequently, in order that the meatus or other seat of the disease may be got into a healthy condition.

Granulations.

More common than polypi, to which they are somewhat allied (the larger ones having a distinct epithelial coat, and consisting of round and oval cells, in a hyaline stroma interlaced with bloodvessels), are the granulations which sometimes abound in these cases, causing considerable discharge. This profuse discharge assists in their formation, and they are very abundant when there is carious bone.

In the meatus, on the tympanic membrane, and in the cavity of the tympanum, are the situations where they are usually found, and they appear as soft round red growths varying in size from a pin's head to a pea. They are very vascular, bleeding freely when touched.

EXPLANATION OF FIGURES.

- FIG. 1.—Polypus growing from roof of the meatus in front of large perforation of tympanum.
- FIG. 2.—Small polypi filling the cavity of the tympanum, causing attacks of vertigo.
- FIG. 3.—Polypus protruding from the tympanic cavity in a case of perforation after scarlet fever.
- FIG. 4.—Small sebaceous tumour in tympanic cavity, with large perforation.
- FIG. 5.—Perforation shown after treatment and removal of polypus, resulting from scarlet fever.
- FIG. 6.—Large perforation of tympanum.
- FIG. 7. Bulging membrane with pinhole perforation and absence of the malleus from displacement.
- FIG. 8.—Healing perforation of the tympanum.
- FIG. 9.—Curious double perforation at either side of the malleus.
- FIG. 10.—Cretaceous masses on the membrane.
- FIG. 11.—Crescentic cretaceous deposit on the membrane.
- FIG. 12.—Large perforation, the result of otitis media from sea-bathing.
- FIG. 13.—Rent parallel with the handle of the malleus, the result of a box on the ear in a child aged eight years.
- FIG. 14.—Rupture below the malleus from a blow with the open hand on the ear in a woman aged thirty-three.
- FIG. 15.—Rupture below the malleus from a box on the ear in a boy.

[In these three cases the ruptures healed with warm boric acid fomentations and the application of leeches in front of the tragus.]

PLATE II.—DISEASED CONDITIONS OF THE MEMBRANA TYMPANI.

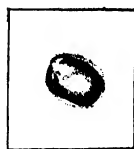


FIG. 1.



FIG. 2.

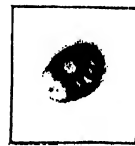


FIG. 3.



FIG. 4.



FIG. 5.



FIG. 6.



FIG. 7.



FIG. 8.



FIG. 9.



FIG. 10.



FIG. 11.



FIG. 12.



FIG. 13.



FIG. 14.



FIG. 15.

Figs. 1 to 12 are from Macnaughton-Jones's Atlas. Figs. 13 to 15 are from sketches by the author (W. R. H. S.).

To face p. 186.

Treatment.—These granulations can be completely removed with the lever-ring forceps (Fig. 66) or ring knife; should any recurrence of the growths take place, the application of chromic acid crystals, nitrate of silver, or a fine cautery point generally causes their disappearance, and it is sometimes useful to puncture the growths before applying the caustic; thorough scraping with a sharp spoon is frequently necessary. The instillation of cocaine and extract of suprarenal capsule is advisable before operating, for the control of the hæmorrhage. It may also be arrested by the application of hot water; no treatment is, however, of any avail unless the primary cause of the discharge is also attacked.

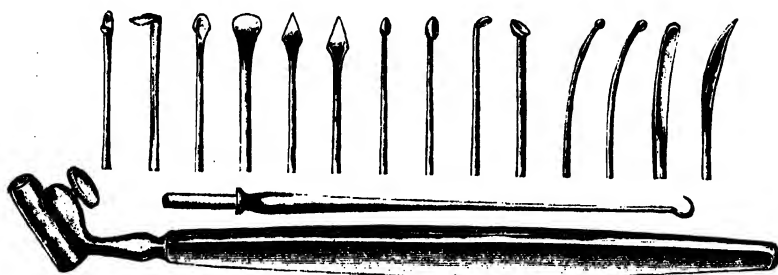


FIG. 101.—SET OF INSTRUMENTS (NATURAL SIZE) FOR INTRA-TYMPANIC OPERATIONS (POLITZER).

CHAPTER IX

COMPLICATIONS OF CHRONIC SUPPURATIVE MIDDLE-EAR DISEASES

BY WILLIAM MILLIGAN

Diseases of the Mastoid Process.

Primary periostitis of the mastoid process is an exceedingly rare affection, and may be due to injury or to the local influence of cold. Cases have been recorded following blows upon the part, forcible pulling of the external ear, etc.

Secondary periostitis is a much more common affection, and frequently complicates disease within the middle ear, atticus epitympanicus, or mastoid antrum. It is also found as the result of extension of inflammation from the tissues of the external meatus; *e.g.*, in cases of diffuse otitis externa, furunculosis, condylomata, etc.

When secondary to suppurative disease within the middle ear or its adnexa, the path of propagation may either be along the fibrous trabeculae or vascular sheaths which ramify between the periosteum covering the process and the mucosa lining the mastoid cells, or along the connective-tissue strands of the squamo-mastoid fissure so frequently unossified in young children. Pathogenic invasion may also take place along bloodvessels or lymph channels connecting the superficial vessels with those ramifying in the mucosa lining the mastoid cells.

Symptoms.—The most distressing symptom is pain, which is usually very severe and persistent, and tends to spread over the same side of the head. It is especially severe at night,

and will keep the patient awake for hours. The least pressure upon the affected part aggravates it. Soon the tissues covering the process become swollen, red, and œdematous, with the result that the auricle is displaced downwards forwards and outwards, and comes to stand away from the side of the head. This characteristic displacement is best observed when the patient is examined from behind (Fig. 102). The œdema may spread over the whole of the affected side of the head, and may in severe cases cause closure of the eyelids. Coincident with the increasing pain and general

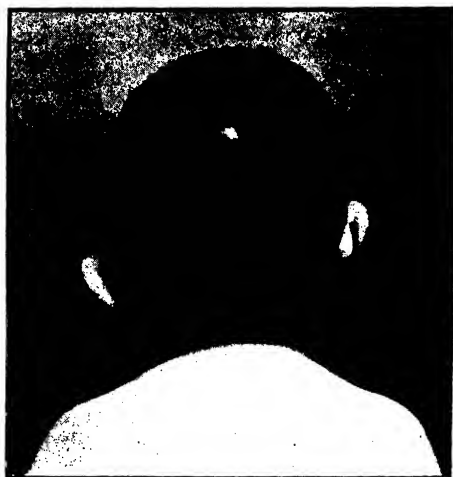


FIG. 102. - MASTOID PERIOSTITIS, SHOWING DOWNWARD, FORWARD, AND OUTWARD DISPLACEMENT OF AURICLE.

discomfort, the patient's temperature will be found elevated and his pulse rapid. In certain cases the inflammatory process may abort, and a return to the normal, without suppuration, take place. Usually, however, pus forms between the periosteum and the bone within a few days of the onset of the disease. Fluctuation may be exceedingly difficult to make out, owing to the infiltration of the superimposed tissues, and to the intimate connection of the periosteum with the underlying bone. Purulent collections may take place either immediately behind the attachment of the

auricle, or towards its upper part in the squamo-mastoid region. At times the abscess may rupture externally, or it may rupture into the external auditory meatus, or track through one of the fissures of Santorini in its cartilaginous portion or at the junction of the cartilaginous with the bony meatus. Should the underlying bone be healthy, recovery soon takes place after evacuation of pus. On the other hand, superficial caries or necrosis may result, and this more especially when recurring attacks of periostitis

take place, or a fistulous tract form in the cortex connecting the subperiosteal abscess with an abscess cavity within the mastoid cells.

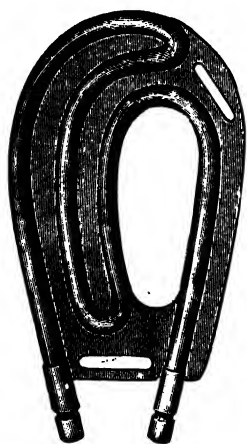


FIG. 103.—LEITER'S COIL

found useful. A layer of lint should be placed between the leaden coils and the skin, and a stream of warm water allowed to flow constantly through the tubes. On the Continent the applica-



FIG. 104.—RUBBE
ICE-BAG.

Treatment.—In the initial stages of mastoid periostitis before suppuration has taken place, energetic efforts should be made to cut the disease short. For this purpose the patient should be kept quiet and in bed in a warm room. A saline cathartic should be administered, and the diet should be bland and nutritious. The local application of heat is useful, and this may be applied by means of boracic fomentations or a Leiter's coil (Fig. 103). Leiter's coil, if employed at an early stage, will be

found useful. A layer of lint should be placed between the leaden coils and the skin, and a stream of warm water allowed to flow constantly through the tubes. On the Continent the application of cold is perhaps more frequently resorted to. A stream of iced water is allowed to flow through the Leiter apparatus, or a specially shaped ice-bag (Fig. 104) is employed. The applica-

tion of vesicants or of counter-irritants should be avoided, tending as they do to mask important symptoms. The local abstraction of blood is particularly

efficacious, and may be effected by means of half a dozen leeches placed over the affected part, or by the employment of Heurteloup's artificial leech (Fig. 105.) Should the inflammatory process, however, show no signs of abatement within thirty-six to forty-eight hours, immediate resort should be had to incision of the indurated tissues, and this even in the absence of definite fluctuation. So far as the writer is aware, no method of treatment gives such speedy relief. The incision—usually called Wilde's incision—is made with a stout scalpel $\frac{1}{2}$ inch behind the attachment of the auricle, and from about the level of the upper border of the external meatus to the tip of the mastoid process. The incision should be carried right down to the bone throughout its entire length, as if pus exists its situation is subperiosteal. Hæmorrhage is, as a rule, free but should be encouraged rather than otherwise, as the relief from local depletion is immense.

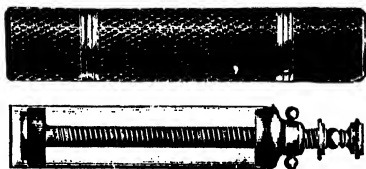


FIG. 105.—ARTIFICIAL LEECH.

It may be necessary to tie the posterior auricular artery or some of its branches. After incision, the œdematous tissues, frequently $\frac{1}{2}$ inch thick, rapidly return to their normal condition. The incision should be kept open for a few days by means of gauze packing introduced right down to the bottom of the wound and throughout its entire length. The writer's practice is to insert a few sutures, at the time of the operation, but not to tie them. Subsequently, when all œdema has subsided, these are tied. This drawing together of the lips of the incision materially hastens the healing of the wound, and produces a firm and neat cicatrix. Should sutures not be inserted, however, the lips of the wound may be ultimately brought into apposition by means of strips of plaster.

If the periostitis be secondary to furuncles in the external meatus, or to catarrhal or suppurative disease within the middle ear, these conditions must be treated accordingly. If

superficial caries of the mastoid cortex exist, the incision must be kept open, and efforts made to promote detachment of any sequestra which may have formed, or which may be in process of formation. Careful examination of the cortex should always be made by means of a probe, and fistulæ searched for. In cases of chronic suppurative middle-ear disease, fistulæ will frequently be found, leading to a definite focus of suppuration within the mastoid process. In such cases, the subperiosteal abscess is a purely secondary phenomenon, and is dependent upon deeper seated disease. Under such circumstances it is necessary to open up the fistulous tract, and to follow the path of the disease, eradicating and clearing out all succulent mucous membrane, granulation tissue and carious bone.

Provided that no intracranial complication exists at the time, the prognosis is good, and complete recovery rapidly takes place.

The effect of incising the periosteum in cases where there is a coincident acute uncomplicated suppurative inflammation of the tympanic mucosa is remarkable. Within a few days the inflammatory process within the middle ear will be found to subside, rapid cicatrization of any existing perforation taking place, with complete restoration of hearing-power.

Should the abscess have pointed in the external meatus, a free incision down to the bone and along its postero-superior wall must be made, and pressure applied externally, so as, if possible, to empty the abscess cavity per meatum.

Acute Suppurative Endomastoiditis.

Probably in all acute suppurative attacks of middle-ear disease there is a coincident acute inflammation of the mucosa lining the mastoid antrum and adjoining mastoid cells. It is only in those cases where occlusion of the *iter ad antrum* from swelling and œdema of its mucous membrane takes place that symptoms of retention of pus follow. The purulent exudation, collecting as it does in what is, for practical purposes, a closed bony cavity, soon causes alarming symptoms. It may be induced also by the application of irritating remedies to

the middle ear, too forcible syringing, the injudicious application of Politzer's bag, exposure to cold, blows upon the part, etc.

Symptoms.—The general symptoms of acute suppurative endomastoiditis consist in rapid rise of temperature, quick pulse, furred tongue, constipation, and general lassitude.

Locally, the main subjective symptom is pain, which is frequently intense, and allows of no rest to the patient. It is usually worse at night, and is of a dull, boring character, due to increasing tension within the affected area. It is aggravated by pressure and percussion. Tinnitus of a rushing or pulsating character is also present, and is due to the engorged state of the surrounding bloodvessels. Vertigo may or may not be present. Should there be any coincident inflammation of the internal ear, it is frequently well marked. Deafness, to a greater or less degree, is always present.

Objective Symptoms.—In most cases swelling and œdema of the superimposed tissue is present, but it must not be forgotten that severe inflammatory disease may exist within the mastoid cells without any superficial objective evidence of its presence. At other times, however, the whole mastoid process appears swollen and blown out. Usually, however, the soft tissues covering the mastoid participate in the inflammatory process, and become swollen and œdematous. Ultimately a subperiosteal abscess may form.

A most important objective indication of endomastoid disease is 'dipping' of the postero-superior wall of the external auditory meatus close to the attachment of the membrana tympani. This prolapse or 'dip' (*la chute*) is so characteristic as to be considered by some authorities a pathognomonic symptom.

Important evidence of the presence of pus within the mastoid cells may also be gained by closely observing the flow of pus through the existing perforation of the membrana tympani. If the membrane be dried by means of a cotton armed probe and carefully watched, pus will soon be found to re-collect. This experiment may be tried time after time with a similar result. The deduction is that the pus is oozing from some reservoir—*e.g.*, mastoid antrum—the amount of

the flow being much greater than could be accounted for if the cavity of the middle ear were the part solely affected. The line of flow of pus has also a practical significance. Thus, if it proceed from the mastoid antrum, its flow is in a *single line over the inner wall of the cavity* from the postero-superior to the postero-inferior segment, passing when the head is held vertically, in front of the fenestra ovalis and fenestra rotunda. If generated within the epitympanum, its flow is diffuse, and over the remains of the inner wall of the membrana tympani.

Percussion of the mastoid process is said by Eulenstein to afford valuable information as to the presence or absence of endomastoid disease. Thus, if in the presence of other inflammatory indications, upon comparing the two sides, dulness upon the affected side exists, the presumption is that pus is present. It must be noted, however, that this test, although possibly valuable, is not absolute, as the area of disease may be so small or so deeply situated as to prevent any dulness being noted. According to Ostino, information of the presence or absence of disease may be obtained by auscultation. Two auscultation-tubes of the same length, diameter, and structure are fitted with aural specula of the same size. The ends having the specula attached are applied against the mastoid processes of the patient, and the free ends are inserted into the examiner's ears. If a vibrating tuning-fork be now placed upon the patient's forehead, it will be found that no lateralization of sound occurs under normal conditions, but that the sound is lateralized towards the affected side when the air-cells within the mastoid process are full of inflammatory products. There is usually a very free discharge of pus, which irritates the walls of the external meatus, leading ultimately to their excoriation.

Course of the Disease.—Empyema of the mastoid cells if left to itself may spread and destroy the bone, eventually perforating the cortex and leading to the formation of a subperiosteal abscess, or pus may track towards the external auditory meatus, finally pointing and discharging per meatum. In certain cases erosion of the tegmen antri may take place, with the result that localized meningitis (with extra-dural abscess) may ensue, or in other cases diffuse suppurative pia-

arachnitis. In yet other cases pus may erode the inner wall of the mastoid process, perforating the bone upon the inner aspect of the digastric groove, and leading to the formation of a deep-seated cervical abscess (under the deep cervical fascia). This form of mastoid disease is described as Bezold's mastoiditis. Extensive caries may result, whilst sequestra of varying size may become exfoliated.

Treatment.—In the early stages of the affection, efforts should be made to cause resolution of the inflammation by means of free leeching, the employment of Leiter's coil, rest in bed, and the provision of free drainage from the middle ear. Should the symptoms, however, show no signs of abate-



FIG. 106.—SHARP SPOONS.

ment within thirty-six to forty-eight hours, no further time should be lost before opening and draining the affected part.

Preparation of Patient.—The evening before the operation a mild purgative should be given. The head should be thoroughly washed with soft-soap and warm water, and the skin thoroughly rubbed with ether to remove all grease. The hair for a few inches round the affected ear should be shaved, and the head wrapped up in a carbolic or perchloride towel for the night.

Instruments required.—Knives, artery forceps, raspatory, retractors, gouges, chisels, mallet, antrum hook, Volkmann's sharp spoons, probes, dissecting forceps, angular forceps, sharp-pointed and blunt-pointed scissors, curved needles in handles, curved and straight needles, needle-holder, syringe, drainage tubes.

Position of Patient.—The patient should lie on a firm table upon his back, his head with the affected side uppermost, resting on a firm sand or horse-hair pillow. A carbolized towel should be tightly wrapped round the head. The anæsthetist should stand facing the patient, and

opposite the operator, whilst the assistant should be placed at the head of the table. A good light is essential; the table should be placed so as to secure for the operator the greatest amount possible. An excellent plan is for the operator to reflect the light by means of an electric forehead lamp or from a limelight lamp placed between the anæsthetist and the assistant.

The Operation.—The auricle having been pulled forwards, an incision of from $1\frac{1}{2}$ to 2 inches in length is made $\frac{1}{2}$ inch



FIG. 107.—FOREHEAD REFLECTOR.

behind its attachment, and extending from the level of its upper border to the tip of the mastoid process. The soft tissues having been divided right down to the bone throughout the whole length of the incision, the periosteum is detached by means of a rasp until the posterior border of the bony meatus is in full view. All bleeding-points should now be secured and the vessels tied. By means of a rake-shaped retractor, the soft tissues are drawn forwards so as to fully expose the surface of the mastoid process.

Landmarks.—In order to expose the antrum, one of two methods may be adopted. If an imaginary line be drawn parallel to the upper border of the external auditory meatus, and another parallel to its posterior border, the triangle formed between the intersection of these imaginary lines and the curved postero-superior border of the bony external auditory meatus will be situated right over the antral cavity. Or the suprameatal triangle (McEwen) may be mapped out. The base of this triangle is formed by the posterior root of the zygoma running above, by the portion of the descending plate of the squamous which forms the arch of the external osseous meatus below, and by a base line uniting the two dropped from the former on a level with the posterior border of the external auditory meatus. Having thus mapped out the antral region, the bone should now be cautiously cut away by means of various-sized gouges, care being taken to cut in a direction downwards and forwards and parallel to the posterior wall of the external auditory meatus. Instead of using gouges, the bone may be opened by means of special burrs driven by a surgical motor. On no account should a trephine or any of the so-called perforators be used, on account of the impossibility of seeing what is being cut away. The depth to which it is necessary to perforate varies much, especially in acute cases. At times pus will be found immediately under the cortex, at other times at a depth of from $\frac{1}{4}$ to $\frac{3}{4}$ of an inch. Great care must be exercised in deep explorations, and frequent use made of the probe and the antrum hook in order to ascertain the nature of surrounding parts. In certain cases it may not be necessary to open the antrum, the purulent collection existing in the superficial and vertical mastoid cells. This is especially prone to be so in post-influenzal cases, the abscess cavity being subcortical. It is probably better to follow no set rule and to adopt no formal operation, but to be guided by the pathological appearances of the part, and to follow the pathogenic tract of the disease. The writer's practice is, after having opened up and cleansed any existing subcortical abscess, to open and inspect the interior of the mastoid antrum. Should disease be found present, careful cleansing

or curetting of the part is performed, but care is taken not to open up the cavity of the middle ear.

After-treatment consists in careful cleansing of the cavity, and in packing so as to insure healing *ab imô*. Many surgeons syringe the part with antiseptic solutions; others prefer the dry method of treatment, mopping up any secretion with an antiseptic wool, and keeping the cavity packed with dry gauze. In certain cases the cavity may be allowed to fill up with blood, and the lips of the incision being



FIG. 108.—PHOTOGRAPH SHOWING CARIOUS EROSION OF GROOVE OF LATERAL SINUS (AUTHOR'S COLLECTION).

brought together, the wound is completely sewn up. The clot becomes organized, and more rapid healing is thus secured.

Chronic Suppurative Endomastoiditis

As the result of chronic suppurative middle-ear disease, the mucosa lining the mastoid antrum and adjoining mastoid cells may participate in the inflammatory process to such an extent as ultimately to lead to disease of the underlying bone, with gradual destruction of the septa between the cells and

the conversion of the greater part of the mastoid process into a large cavity filled with the products of chronic purulent inflammation, pus, granulation tissue, carious bone, sequestra, etc.

Disease within the mastoid area is especially prone to take place when obstruction to the exit of pus from the middle ear is present; *e.g.*, in cases where the existing perforation of the membrana tympani is small, situated high up upon the surface of the membrane, or nipple-shaped. The presence of granula-



FIG. 109.—PHOTOGRAPH SHOWING CARIOUS EROSION OF TEGMENA ANTRI ET TYMPANI (AUTHOR'S COLLECTION).

tion tissue or of polypi within the middle ear also favours retention and decomposition of secretion.

Course and Consequences.—The longer purulent disease exists within the mastoid area, the greater is the destruction of bone, and the greater the risk to the patient. Frequently the destructive process, a cario-necrosis, works towards the surface, eroding the cortex, and ultimately producing a fistula. A subperiosteal abscess may or may not form. On the other hand, erosion of the bone may take place in the direction of

the groove for the lateral sinus (Fig. 108), ultimately exposing the sinus and causing suppurative periphlebitis with thrombosis. In yet other cases the roof of the antrum, and possibly also of the middle ear (Figs. 109 and 110), may become perforated, leading in the long-run to serious intracranial disease. The posterior part of the vestibule or the external semi-circular canal may also become eroded, thus affording pathogenic organisms a direct path to the internal ear, from whence they are readily carried along the sheaths of the



FIG. 110.—PHOTOGRAPH SHOWING CARIOUS EROSION OF TEGMEN TYMPANI (AUTHOR'S COLLECTION).

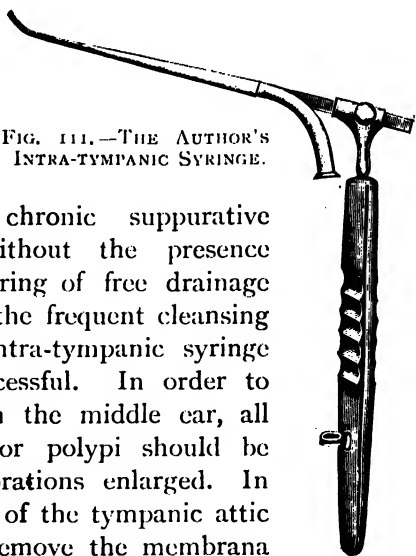
facial or auditory nerves to the interior of the cranium. In a few cases the inner table of the mastoid process becomes perforated, leading to the formation of a deep cervical abscess, Bezold's mastoiditis.

Symptoms.—*Subjective.*—Pain is, as a rule, absent, except when an intercurrent attack of inflammation takes place, or when the disease has invaded the interior of the cranium. Suppuration round cholesteatomatous masses within the mastoid also gives rise to attacks of pain and rise of temperature. Swell-

ing and œdema of the tissues covering the process are absent as a rule.

Objective.—The most important objective indication is the constant discharge of pus, usually very foetid, frequently blood-stained, and occasionally containing particles of broken-down bone or cholesteatomatous débris. Ocular inspection may at times reveal the presence of bone disease, but more usually recourse has to be had to a careful exploration of the part with a bent probe. Under good illumination, the probe is introduced through the existing perforation of the membrane upwards and backwards along the *iter ad antrum* towards the mastoid cells. Bare bone, at times quite soft, may thus be felt. In other cases, however, the existence of bone disease may have to be assumed from the presence of a very chronic and foetid purulent discharge, uninfluenced by treatment and by the establishment of free drainage from the middle ear.

FIG. 111.—THE AUTHOR'S
INTRA-TYMPANIC SYRINGE.



Treatment.—Where chronic suppurative endomastoiditis exists without the presence of bone disease, the securing of free drainage from the middle ear and the frequent cleansing of the cavity with an intra-tympanic syringe will at times prove successful. In order to secure free drainage from the middle ear, all granulation tissue tufts or polypi should be removed and small perforations enlarged. In cases of associated disease of the tympanic attic it may be necessary to remove the *membrana tympani*, the *ossicula auditûs* (malleus and incus), and the outer attic wall. Anything approaching thorough cleansing of the antrum and adjoining cells is necessarily difficult, from their depth from the surface and from the difficulty of reaching them per meatum. By means of an intra-tympanic syringe (Fig. 111) antiseptic lotions may be passed well into the affected parts, and by means of a Siegle's speculum pus may be drawn from the depths to

the surface. Solutions of hydrogen peroxide (10 to 20 volumes) are particularly useful for cleansing purposes.

Failing the arrest of the disease by local measures, the question of operative interference has to be considered. There exist certain well-recognised indications for opening and draining the mastoid cells in chronic cases. Thus, the mastoid process should be opened in cases of—

1. Chronic suppurative disease of the mucosa with recurrent attacks of inflammation, with carious or necrotic bone disease.

2. Where a fistula through its cortex leads down to areas of diseased bone.

3. Where cholesteatomatous masses are present.

4. Where there is chronic suppurative middle-ear disease with symptoms of retention of pus.

5. Where there is chronic suppurative middle-ear disease (without retention of pus) accompanied by foetid discharge which has resisted all ordinary methods of intra-tympanic treatment.

6. In cases of persistent pain (neuralgic) over the process.

7. Where there is a danger of retention of pus from stenosis of meatus, hyperostoses, exostoses, etc.

8. As a preliminary to operation for the intracranial lesions of chronic suppurative otitis media.

Great difference of opinion exists, however, as to the advisability or non-advisability of operating in those cases where pain is absent, where the definite proof of bone disease is not forthcoming, but where there is a continuous discharge of pus, usually foetid and uninfluenced by any form of local treatment. Although probably no hard and fast rule can be laid down as to the expediency of operating in such cases, the intuitive knowledge gained by prolonged experience will be found invaluable in the determination of this particular point.

Object of the Operation.—The object sought after is (1) to freely lay open and cleanse all loculi containing pus and diseased mucous membrane; (2) to remove all carious or necrotic bone disease, cholesteatomatous masses; and (3) to ultimately secure a layer of healthy tissue between the middle ear and the cranial cavity.

Preparation of Patient.—The evening before the operation a mild purgative should be given. The head should be well washed with soft-soap and warm water, and the skin

FIG. 112.—RASPATORY.

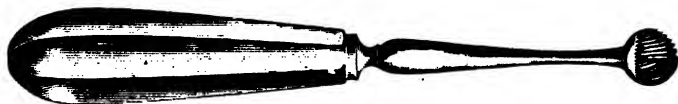


FIG. 113.—ROTATORY BURR.

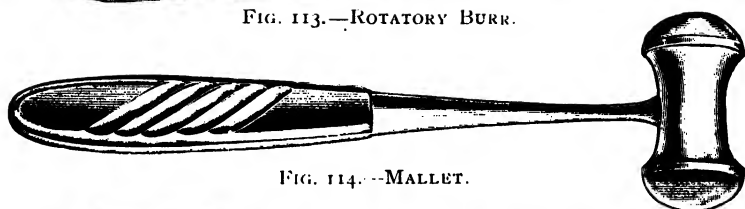


FIG. 114.—MALLET.



FIG. 115.—GOUGE.



FIG. 116.—CHISELS.



FIG. 117.—RAKE RETRACTOR.

thoroughly rubbed with ether to remove all grease. The hair for a few inches round the affected ear should be shaved, and the head wrapped up in a carbolic or perchloride towel for the night.

The Mastoid Operation.—In those cases where there is reason to suppose that the diseased process is confined to

the *attic*, the *iter ad antrum*, and the *antrum* itself, the operation designed by Professor Stacke is the one now usually performed.

Stacke's Operation.—A curved incision is made parallel to the attachment of the auricle, and along the line of the hair from a point commencing at the attachment of the helix to the side of the head downwards and backwards to the tip of the mastoid process. The first incision should divide the skin and structures superficial to the periosteum. All bleeding-points are caught and ligated at once. The second incision (the superficial structures having retracted slightly) should be carried through the periosteum and down to the bone. By means of a raspatory (Fig. 112) the periosteum is detached in a forward direction until the posterior border of the bony meatus is in full view. The cartilaginous meatus is now detached from its attachment to the posterior and upper meatal wall, and the whole auricle and detached portions of the meatus are drawn forwards by means of a broad rake retractor (Fig. 117) on to the side of the face. A convenient method is to pass a broad strip of lint or gauze through the meatus and over the auricle, so that the parts may be held forwards by an assistant. In this way the *membrana tympani* or its remains is fully exposed, and may, along with carious ossicles, be removed. The outer attic wall is now carefully cut away by means of a Stacke's

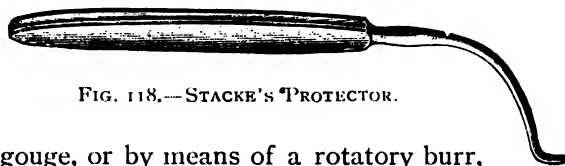


FIG. 118.—STACKE'S PROTECTOR.

special gouge, or by means of a rotatory burr, a Stacke's protector (Fig. 118) having previously been introduced, until whilst touching the *tegmen tympani* it can be withdrawn without meeting with any obstruction. In this way the whole cavity of the attic is freely exposed, and should the *incus* be visible, it is easily removed at this stage by means of an *incus hook*. All diseased mucous membrane and carious bone are now removed by small spoons or curettes, or by means of small burrs worked by an electro-

motor or dental engine (Fig. 119).* The outer portions of the mastoid process and the postero-superior wall of the meatus are next removed by means of gouges or burrs, great care being taken when working in the vicinity of the facial nerve. After the antrum has been thoroughly cleansed, a free communication should exist between it and the external auditory meatus. The cartilaginous meatus (Fig. 121) is now split from within outwards along the centre of its upper wall as far as the concha (A B). A second incision (A C) is made at right angles to the first, and the cartilaginous curtain (A B C D) thus formed is turned downwards and backwards, and is held *in situ* by gauze packing, or by one or two sutures passed

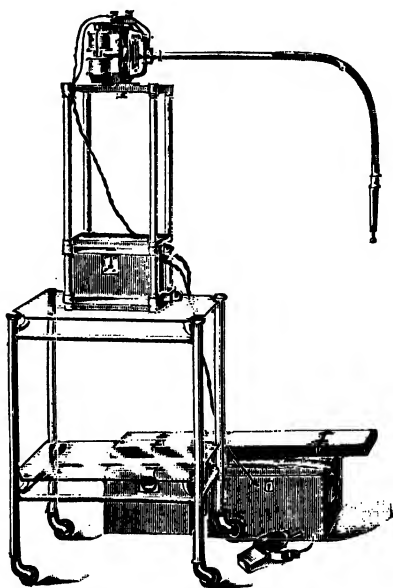


FIG. 119.—BALLANCE AND MILLIGAN'S SURGICAL MOTOR (ELECTRIC).

* The illustration (Fig. 119) depicts the apparatus designed by C. A. Ballance and W. Milligan to meet the want felt by many surgeons for a motor which can be carried about to private operations. The 16-volt accumulator is of the sealed type, having a capacity of 18 ampère hours and weighing about 34 lb. The motor is of the type known as the 'D' pattern, so called on account of the shape of the field magnet. The armature is a gramme ring, and is attached directly to the shaft which carries the cable, thus acting the part of a fly-wheel. It weighs about 15 lb., and is mounted on a gun-metal turn-table, which enables it to rotate and follow the movements of the operator. The turn-table is mounted on a platform, at each corner of which are sockets, and similar sockets are attached to the steel frame which surrounds the accumulator. Into these sockets steel tubes are fitted, which form a rigid stand at a convenient height. The accumulator acts as a secure base for the motor when in action. The metal cable is directly attached to the central shaft of motor, and is covered with a flexible metal tube which can be boiled. The

through the adjoining soft tissues. The post-auricular wound is left open for a time, and subsequent packing takes place both *per meatum* and from behind the ear. In successful cases the cavity thus formed—the antro-tympanic cavity—becomes papered by a layer of delicate epithelium derived from the meatal flap described above.



FIG. 120.—BARTH'S SELF-RETAINING MASTOID RETRACTOR.

Frequently, however, there are evidences of extensive disease within the mastoid area. Under such circumstances it is usual to open the mastoid antrum first, and then to remove the bridge of bone between the antrum and the middle ear, finally extending the area of operation until all diseased mastoid cells have been opened and all carious bone removed. This operation is usually

handpiece is attached to the cable by means of a left-handed screw. It is perfectly plain in design, so as to allow no corners for the accumulation of dirt. The drills, saws, and other tools are held in position by a spring clutch acting in a groove in their shanks, and are easily fixed or removed. The handpiece is in two parts. The outer portions form the handle, and act as a bearing for the inner portion, which is the spring clutch already referred to. The cable and handpiece are supported by a rigid steel tube, terminating in a spring, which relieves the operator almost entirely of their weight, and allows of much greater delicacy of touch than would otherwise be possible. The motor is started and its speed regulated by means of a foot switch. The apparatus ready for use is shown in the figure, and when dismantled fits into three packages shown at the foot of the same figure. The case on the left is the accumulator. That on the right contains the motor, stand, turn-table, switch, and other fittings; the package on the top, which is a kind of gun case, carries the legs of the stand and the flexible arm. The entire apparatus, with cases included, weighs about 70 lb. For hospital work the motor is wound to suit the voltage of the main current. It is mounted on an enamelled steel pedestal, fitted with ball-bearing castors. Burrs, drills, a small trephine, and Cryer's drill can be used with the motor.

called the Schwartz-Stacke operation, and is performed as follows:

The Schwartz-Stacke Operation.—The preliminary steps—the incision and the mapping out of the point at which the bone should be perforated—are similar to those described (p. 196)

in connection with the performance of the operation for acute antral empyema. The mastoid antrum having been cautiously opened, a protector, *e.g.*, Stacke's, is passed under the bridge of bone which separates the antrum from the middle ear. This

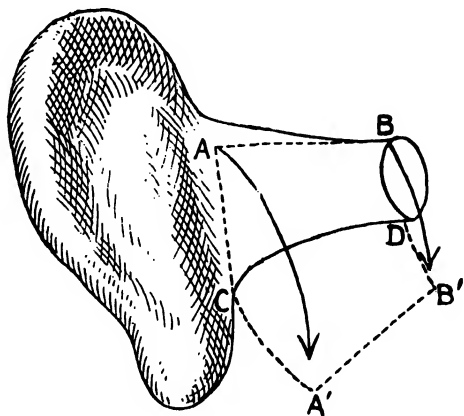


FIG. 121.—SCHEMA OF FLAPS (STACKE).
(After Lermoyez.)

triangular bridge of bone, with its base uppermost, is now cut away, great care being taken in removing its deeper portions to avoid injury to the facial nerve, which lies immediately under it. In this way the cavity of the middle ear, the *iter ad antrum*, and the antrum itself are fully exposed. All remains of the membrana tympani, with the attached ossicles (malleus and incus), are removed, and the outer attic wall carefully chipped away by means of Stacke's chisel.

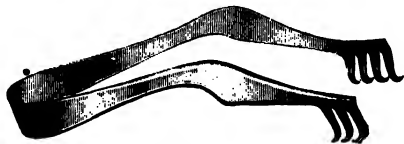


FIG. 122.—MASTOID RETRACTOR.

Any mastoid cells which appear to be diseased are opened and cleansed, great care being observed and frequent use made of the exploring antrum hook so as to avoid injury to such structures as the lateral sinus, the middle fossa, etc. In this way the middle ear, the antrum, and the adjoining mastoid cells are thrown into one large cavity—the antro-

tympenic cavity—which is now thoroughly cleansed, all diseased mucous membrane, etc., being carefully curetted.

In order to cover the bony walls of the antro-tympanic

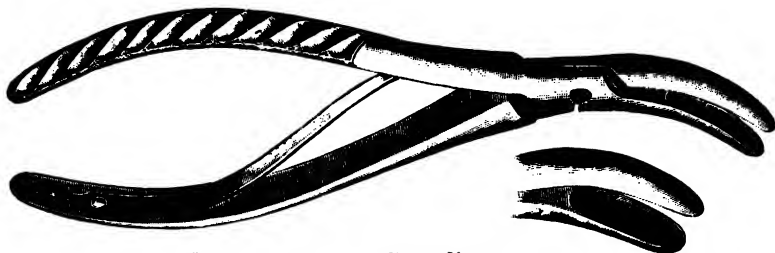


FIG. 123.—CUTTING BONE-FORCEPS.

cavity, the cartilaginous portion of the external auditory meatus is utilized as far as possible.

Various methods are in vogue. Thus Panse recommends making one incision (Fig. 124, A B) along the centre of the posterior wall of the cartilaginous meatus as far outwards as the concha, and another (C D) at right angles to this first at

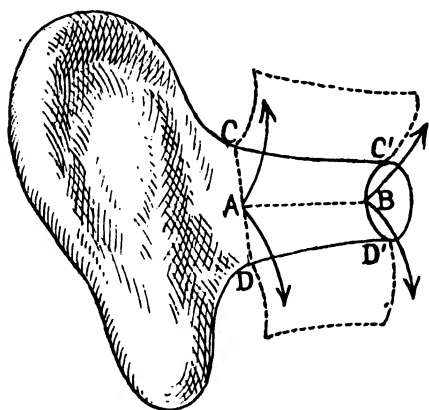


FIG. 124 —SCHEMA OF FLAPS (PANSE)
(After Lermoyez.)

the point where the horizontal incision (A B) ends in the concha. In this way two quadrilateral flaps (A B C C' and A B D D') are formed. The upper is hinged upwards through an imaginary axis (C C'), and the lower downwards through an imaginary axis (D D'). These flaps cover respectively a portion of the roof and floor of the antro-tym-

panic cavity. They are kept *in situ* either by means of strips of gauze introduced *per meatum* or by stitches passed through the adjoining soft structures, and from their edges epidermization of the bony walls of the cavity proceeds.

Körner recommends making an incision (Fig. 125, AB) along the upper border of the posterior wall of the cartilaginous meatus, and another (CD) along its lower border, both incisions being carried well into the concha. A quadrilateral flap (ABCD) is thus formed. This flap is hinged backwards through an imaginary axis (BD) against the bony wall of the mastoid cavity, and is kept *in situ* either by packing or by sutures. Before being pressed into position, any redundant tissue is cut away from the posterior surface of the flap, so that the apposition of the soft parts to the underlying bone may be as intimate as possible.

The enlarged external auditory meatus which is thus produced is held by some to be a disadvantage on account of its unsightliness; by others to be of distinct advantage, facilitating subsequent dressing and inspection.

The original skin incision is now carefully sewn up, and all subsequent dressings are conducted through the external auditory meatus. The usual superficial dressings are applied, and are changed every two or three days. The deep dressing need not be disturbed—provided there is no undue rise of temperature or any untoward sign—for about a week. After that time it should be changed every third or fourth day.

The idea in the mind of the surgeon should be to get the whole antro-tympanic cavity lined with a layer of dry epithelium derived from the cut edges of the flap or flaps. With this end in view, it will be found necessary to carefully inspect the interior of the cavity at each dressing, and to cauterize or to scrape away any exuberant granulation tissue arising from the bony walls, so as to assist the

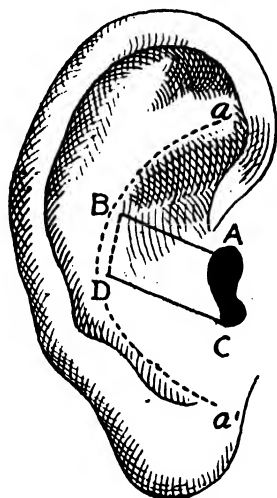


FIG. 125.—SCHEMA OF FLAPS (KÖRNER). (After Lermoyez.)
aa' Line of attachment of external ear.

DISEASES OF THE EAR

gradual creeping of epidermal cells over the walls of the cavity. For this purpose it is also necessary to pack the cavity with a certain degree of firmness. In from three to four months after the operation the cavity should be entirely papered with epithelium, and upon inspection its walls should have a dry, lustrous, pearly appearance.

The after-treatment—the packing, cauterizing, etc.—is, however, both tedious and troublesome, and does not always end in securing a covering of epithelium for the whole of the operation area. Thus the inner tympanic wall will frequently remain uncovered, leaving an exposed surface of mucous membrane, which may from time to time discharge pus or muco-pus.

An important advance in the treatment of mastoid sup-puration has recently been advocated by C. A. Ballance, who recommends the covering of the whole of the walls of the antro-tympanic cavity by means of a large skin-graft. Other authorities, notably Siebenmann, had previously recommended the use of small Tiersch grafts with a similar end in view.



FIG. 126.—LINE OF INCISION IN CONCHA.

Ballance divides his operation into two distinct stages. The first operation is designed to remove all bone disease, and is conducted upon the principles of the Schwartz-Stacke operation, the principal modification being his method of dealing with the cartilaginous flap. By means of a long and narrow knife the inferior wall of the canal is divided from within outwards well into the concha. The incision (Fig. 126) in the concha is then carried with a curve upwards

and backwards until it reaches the level of the anterior commencement of the helix. The flap thus formed is pushed upwards and backwards against the bone, forming a portion of the roof of the cavity, and is held *in situ* by means of two or three silkworm stitches passed through the adjoining soft

THE 'GRAFTING' OPERATION

parts (Fig. 127). The cavity is now thoroughly cleansed with warm 1 in 20 carbolic lotion, and packed with a long and narrow strip of gauze, the end of which is brought out through the enlarged meatus. The original skin incision is sewn completely up, and the usual dressings are applied.

The Second or Grafting Operation.—In adults this is usually performed after the lapse of from ten to fourteen days; in children, under favourable circumstances, it may be done at the end of a week. The day preceding the second operation the gauze plug is removed, and the cavity well irrigated with warm carbolic lotion. On the morning of the operation the cavity is washed out three or four times with warm sterile normal salt solution.

When the patient is under the influence of an anæsthetic, the original incision is opened up and the soft parts drawn well forwards by means of a broad retractor. Hæmorrhage is now arrested

by pressure, or by frequent syringing with warm saline solution. When the cavity has been thoroughly dried by means of small pieces of dry gauze held upon a pair of angular forceps, its walls are seen to be covered by a delicate

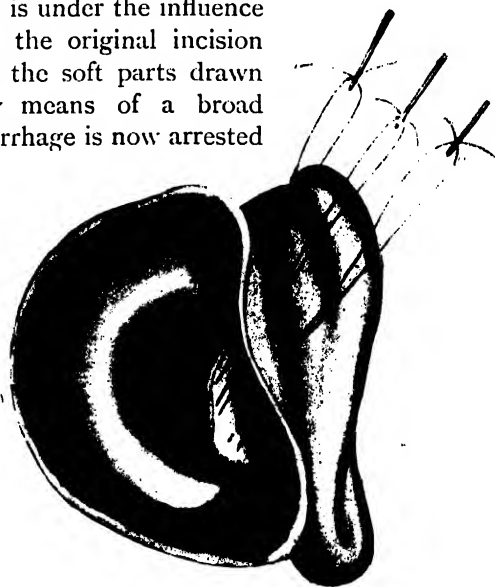


FIG. 127.—SILKWORM SUTURES IN SITÛ.

layer of pale pink granulation tissue, and it is to this layer that the graft is to be applied. A large skin-graft— $1\frac{1}{2}$ to 2 inches square—is now cut from the thigh or arm by means of a razor or special grafting-knife, and is floated off into a flat dish containing warm sterile salt solution. It is now

carried to the wound upon a large 'lifter' (Fig. 128), the anterior extremity of which is placed against the outer or superficial edge of the anterior wall of the bony cavity. The graft is now coaxed on to this superficial edge, and



FIG. 128.—LIFTER FOR GRAFT.

also above on to the adjoining superficial edge of the roof of the cavity just below the linea temporalis, and kept in position by means of long and delicate needle-probes (Fig. 129). By careful manipulation the graft can now be made to cover the following parts :

1. The anterior wall of the cavity, formed internally by the anterior boundary of the tympanum and attic, and externally by the anterior wall of the enlarged osseous meatus.
2. The anterior part of the roof of the cavity formed by



FIG. 129.—STRAIGHT AND ANGULAR NEEDLE-PROBES.

the tegmen tympani and the superior wall of the enlarged osseous meatus.

3. The inner walls of the attic and tympanum.
4. The tegmen antri.
5. The ridge formed by the Fallopian aqueduct.
6. The inner wall of the antrum.

The graft is gently pressed 'home' against the bony walls



FIG. 130.—STEEL STOPPERS.

of the cavity by means of specially constructed steel stoppers (Fig. 130), any air or blood which may be lying between the

graft and the underlying bone being carefully sucked up by means of a fine pipette (Fig 131). In this way the antrotympanic cavity is lined by a continuous sheet of delicate epithelium. To protect this, a film of pure gold-leaf ($\frac{1}{100,000}$ to $\frac{1}{20,000}$ of an inch in thickness) is gently insinuated into the cavity, and pressed down by stoppers until all eminences and depressions are accurately mapped out in gold. A thin strip of gauze (cyanide or iodoform) is now gently packed into the cavity, and brought out through the external auditory meatus. The skin incision is carefully sewn up again, and the usual dressings are

applied. The external dress-

ings may be changed every day, or every second day, if necessary, but the deeper dressing should be left *in situ* for a week, if possible. It is then carefully removed, and the cavity inspected. The gold-leaf

is removed at the end of ten days by a pair of angular forceps. Inspection of the cavity (provided everything has gone on favourably) should now show a dry epithelial surface. By this method recovery is much more rapid, and the numerous and painful dressings previously necessary are dispensed with.

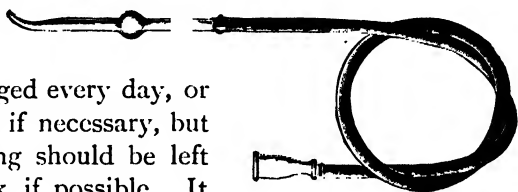


FIG. 131.—PIPETTE.

Mastoid Disease in Influenza.

The peculiar characteristics of mastoid disease in influenza are the severity of the inflammatory process, the rapidity with which the bone is affected, and the tendency to the formation of subcortical apical abscesses. It would seem almost as if the antral cavity and the surrounding mastoid cells enjoyed some peculiar immunity, so frequently is the purulent collection found to be subcortical and apical. In such cases pain is severe, and aggravated by the least pressure. Secondary periostitis is common, and if pus is not liberated at an early date, perforation of the cortex, and, more rarely, of the inner mastoid table, takes place.

In the treatment of such cases the apical cells should be

freely opened up and curetted, and, if thought advisable, the antrum may be explored at the same time. Care should also be taken to secure free drainage from the middle ear by enlarging, if need be, any existing perforation, or by the removal of any succulent granulation tissue. Liberal diet and tonics are also indicated.

Bezold's Mastoiditis.

In certain rare cases of purulent disease within the mastoid cells, perforation of the bone may take place through the inner mastoid table in the neighbourhood of the digastric groove and under the deep cervical fascia. In such cases pus collects deeply in the neck, and forms a hard, brawny, and indurated swelling. It may track downwards towards the mediastinum, or inwards towards the pharynx. Such cases are described as Bezold's form of mastoiditis.

Treatment.—It is necessary to open the mastoid antrum and to freely ablate the apical cells, and it is advisable also to make a counter opening low down in the neck, so that efficient drainage may be secured. This is best effected by passing a long probe downwards into the neck, following the course pus has taken, and then making it project outwardly, usually in front of the anterior border of the sterno-mastoid muscle. An incision is then made down on to the probe, and a drainage-tube drawn through. Free irrigation is now possible. The after-treatment is usually, however, somewhat tedious.

Diabetic Mastoiditis.

Patients suffering from diabetes are peculiarly liable to acute attacks of otitis media, and to rapid implication of the adjoining mastoid cells. The middle-ear affection may be comparatively slight, whilst extensive disease is progressing within the mastoid area.

The main peculiarity of diabetic inflammation of the mastoid cells is the tendency which exists to the rapid disintegration of bone and to the formation of sequestra, which may involve not only large portions of the pars mastoidea, but also of the tympanic walls. The discharge is, as a rule, profuse, and is frequently blood-stained.

The diminished alkalinity of the blood has been said to have a definite relation to this destructive process by lessening the activity of the antitoxin-forming cells.

The presence of diabetic inflammation of the mastoid cells calls for early operative interference. Free drainage should be secured as soon as possible by paracentesis of the membrana tympani and opening of the mastoid antrum. The main risk in such cases is from the administration of the anæsthetic. Prior to any operative interference, rigid anti-diabetic diet should be prescribed and large doses of bicarbonate of soda ordered.

When diabetes is complicated by albuminuria, operation is contra-indicated.

Tubercular Disease of the Mastoid Process.

Tubercular disease of the mucosa lining the mastoid antrum, and adjoining mastoid cells, may be primary or may be secondary to tubercular disease of the middle ear or other organs—*e.g.*, lungs. In whatever way the tubercle bacillus reaches the middle ear or mastoid area, whether by aerial conduction along the Eustachian tube or by vascular conduction along bloodvessels or perivascular sheaths, it finds within the interstices of this region a habitat suitable for its development. In course of time minute tubercles, which become deposited in the mucosa, tend to coalesce, to undergo ulceration, and to lead to erosion of the underlying bone. Extensive destruction of the septa between the mastoid cells leads to the formation of cavities containing broken-down tissue, fungous granulations, and purulent débris. At times sequestra of large size form, and by their exfoliation expose important structures—*e.g.*, the dura, the sigmoid sinus, the labyrinth, etc.

The peculiar characteristics of tubercular disease of the temporal bone are painless onset, erosion and painless destruction of the membrana tympani, early occurrence of facial paresis or paralysis, and enlargement of the periotic ganglia.

The presence of such a group of symptoms, although suggestive of an underlying tubercular process, does not, however, prove it. The detection of bacilli in the dis-

charges from the part, or in the fungous granulations around sequestra, or the artificial production of tuberculosis in animals inoculated with fragments of diseased tissue, is necessary before a definite diagnosis can be made.

Great destruction of the temporal bone may take place without any definite objective indications. The whole interior of the mastoid process, and even of the pars petrosa, may be converted into a mass of cheesy pulp, a mere framework of dense bone remaining, upon which the base of the brain is poised.

Such cases usually occur in poorly-nourished children, in

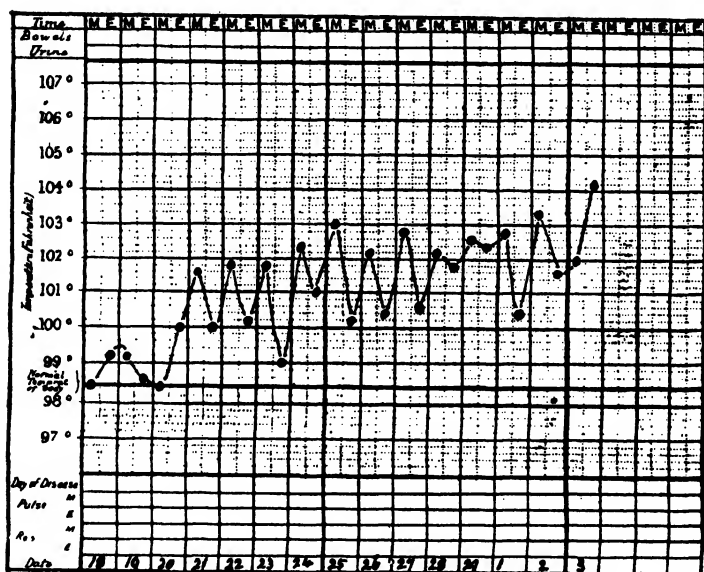


FIG. 132.—TUBERCULAR MASTOID DISEASE. MENINGITIS. DEATH.

whom the powers of resistance are so diminished as to permit of the growth and development of the bacillus.

Symptoms.—The main symptoms are objective in character, and consist in the presence of a free discharge, usually very foetid and occasionally blood-stained, the early appearance of facial paresis or paralysis, the early enlargement of the periotic ganglia, and the occasional formation of recurring and sluggish subperiosteal abscesses. Intercurrent attacks

of acute inflammation may take place, and are due to the action of pathogenic organisms—*e.g.*, streptococcus, staphylococcus, etc.

Course and Duration.—The general condition of the patient and the character of his surroundings will materially influence the prognosis. At the best the outlook is not very hopeful, partly owing to the difficulty of eradicating the tubercular bone lesion, and partly also to the liability of such complications as meningitis, enteritis, marasmus, etc.

Treatment.—The main indications are to support the patient's strength by the administration of plenty of good food, fresh air, and if possible, residence in the country or at the seaside.

Locally, free retro-auricular drainage should be secured and maintained, sequestra removed, and carious foci scraped and swabbed with pure carbolic acid or strong solutions of chloride of zinc. Extensive operations are to be deprecated, owing to the almost invariably low state of vitality of the patient.

The occurrence of secondary tubercular deposits in the middle ear or mastoid area in patients suffering from pulmonary phthisis must be regarded as of serious import. In such cases operative measures are, as a rule, contra-indicated.

Malignant Disease of the Mastoid Process.

Malignant disease of the mastoid process may be primary or it may be secondary, and due to extension from surrounding parts—*e.g.*, parotid gland, middle or external ear, etc.

It occurs either in the carcinomatous or sarcomatous form, the former being more common in those over forty years of age, the latter in children and adults.

Sarcoma as a primary disease within the mastoid process is rare. Cases are, however, on record where it has invaded the mastoid area as the result of extension from the middle or external ears, the fibrous layer of the dura mater, the sheath of the auditory nerve, the parotid gland, etc.

Sarcomata of the mastoid area are characterized by their rapid progress, their tendency to hæmorrhage and to the occurrence of facial paralysis, and by the formation of large

fungating masses of exuberant granulation tissue, which recur with great rapidity after removal.

Occasionally the sarcomatous mass may be so soft and diffuent as to convey the impression of the presence of a subperiosteal abscess.

The discharge which is present is usually very foetid and sanious. At a late stage in the course of the disease, the periotic ganglia may become enlarged.

The *prognosis* depends upon the histological structure of the growth, its exact situation, and the age of the patient.

Small round-celled sarcomata are more malignant than large round-celled or spindle-celled growths, whilst the osteo-sarcomata are the least malignant of all.

Treatment.—It is rare that mastoid sarcomata can be successfully eradicated. Free opening of the mastoid process may, however, be called for as a prophylactic measure to relieve pain and to afford drainage.

Carcinoma of the mastoid is also rare as a primary disease, but is occasionally met with as the result of extension from surrounding tissues—*e.g.*, external ear, external meatus, etc. Chronic suppurative middle-ear disease would appear to be a fairly frequent predisposing cause.

The main symptoms are constant and severe pain, intermittent hæmorrhage from the ear, great enlargement of the periotic ganglia, facial paralysis, progressive inanition, and a tendency to the formation of secondary metastatic deposits.

Treatment must be palliative. The liberal use of anti-septic irrigations gives a certain amount of relief. Opium, as a rule, has to be resorted to at an early stage, and should be freely given.

Death is, as a rule, due to inanition, profuse hæmorrhage, or to extension to the meninges. Sinus thrombosis, or a secondary intracranial abscess, may, however, be the proximate cause of a fatal issue.

Cholesteatomata.

Originally, cholesteatomata, or pearl tumours, were looked upon as distinct neoplasms (Virchow). In the present light of our pathological knowledge they are regarded as the

product of long-continued suppuration when accompanied by carious erosion of bone or ulceration of the mucosa. Microscopically, they consist of masses of epithelium more or less concentrically arranged, purulent débris, and cholesterine crystals. They are found to swarm with micro-organisms, and by their gradual enlargement or growth erode the surrounding bony parietes, and often with dangerous results. The epithelial cells of which they are composed are derived partly as the result of an ingrowth of epithelium through a perforated tympanic membrane, and partly from the inflamed and suppurating mucosa of the middle ear or mastoid antrum, and from the carious and eroded bone with which they are usually associated. As they increase in size, the outermost cells become pressed up against the surrounding bone, and flattened out in such a manner as to form a spurious capsule.

In size cholesteatomata vary immensely. At times they are quite small, and situated in the epitympanum; at other times they may be as large as a walnut or a bantam's egg, and occupy the greater part of the mastoid process, encroaching at times upon the occipital region. Even after removal they show a marked tendency to recur, but this is probably due to the fact that all the accompanying disease—*e.g.*, carious bone—has not been completely eradicated.

Symptoms.—Cholesteatomata may lie dormant within the middle ear or mastoid process for long periods without giving rise to any marked symptoms. Swarming as they do, however, with organisms, they are liable to be lit up into marked activity by intercurrent inflammatory attacks, with the result that suppuration is induced around them, with its accompanying risks and dangers. In such cases pain is a marked symptom, temperature rises rapidly, and septicæmic symptoms may be induced.

Treatment.—If small, and situated in the attic, they may be removed by means of scoops, curettes, etc. Usually, however, it is necessary to perform a more elaborate operation, opening the mastoid process, scooping out all purulent débris and succulent granulation tissue, and removing freely and completely all carious bone.

Some authorities—*e.g.*, Rheinhardt—recommend the maintenance of a permanent retro-auricular fistula ; others suggest lining the cavity with healthy skin according to the methods advocated by Siebenmann, Ballance, etc.

If desired, the retro-auricular fistula may be subsequently closed by means of a plastic operation.

Intracranial Complications Secondary to Suppurative Disease of the Middle Ear and its Adnexa.

The various intracranial complications which follow chronic suppurative disease of the middle ear (much more rarely acute otitis media) may be classified as follows :

Extradural abscess.

Subdural abscess.

Meningitis { pachymeningitis.
 { leptomeningitis.

Intracranial abscess { cerebral.
 { cerebellar.

Thrombosis of the venous sinuses (especially of the lateral sinus).

The paths along which pathogenic organisms travel to reach the interior of the cranium are as follows :

1. Through carious erosion of bone—*e.g.*, tegmen tympani, tegmen antri, labyrinth, etc.

2. Along certain vascular, perivascular, or lymphatic channels ramifying between the cavity of the middle ear and the interior of the brain.

3. Along fibrous trabeculæ connecting the dura mater with the mucosa of the middle ear.

4. Along unossified sutures—*e.g.*, the petro-squamosal.

5. Along certain nerve-sheaths—*e.g.*, auditory, facial.

The most frequent pathway is undoubtedly through carious erosion of some portion of the bony parietes of the middle ear and its adnexa, and the sites of election are :

(a) The roof of the tympanum or mastoid antrum.

(b) The inner and posterior wall of the middle ear in the neighbourhood of the groove for the lateral sinus.

(c) The posterior wall of the pars petrosa in the neighbourhood of the internal auditory meatus.

In these situations the bone separating the purulent focus from the dura mater is at no times very thick, is always perforated by minute apertures for the passage of small bloodvessels, nerves, and strands of connective tissue, and is even occasionally incompletely ossified. As the result, therefore, of ulceration of bone, or as the result of simple continuity or contiguity of tissue, pathogenic organisms may be readily conveyed to the interior of the cranium.

Septic infection may also be conveyed along the sheaths of the auditory or facial nerves to the cerebellar fossa. As the result of chronic suppurative middle-ear disease, erosion of the inner tympanic wall may result. Should this erosion occur in the region of the stapedio-vestibular articulation, the vestibule is exposed; if around the fenestra rotunda the cochlea becomes opened up, as it is also when the outer labyrinthine wall (the pars promontoria) is destroyed by caries. The labyrinth having thus been opened up, it is possible for pus to track along the sheaths of the auditory or facial nerves through the lamina cribrosa to the cerebellar fossa. By destruction also of the bony walls of the aqueductus Fallopii in cases of middle-ear disease, septic organisms may find their way to the interior of the cranium.

The lymphatic plexuses surrounding the great bloodvessels which run in close relationship to the middle and internal ear may be the means of conveying infection. Thus the internal carotid artery, which lies upon the median side of the inner tympanic wall, may become infected, or the bulb of the jugular vein, which lies close to the floor of the middle ear (sometimes actually appearing in the middle ear, owing to a dehiscence in its floor), may become inflamed and ultimately thrombosed.

Septic infection of the intracranial contents would doubtless be much more frequent than it is were it not for the fact that in old-standing cases of suppurative middle-ear disease the dura is prone to become thickened and soldered down by plastic inflammation to the underlying bone, or covered by a layer of protective granulation tissue. This conservative effort of Nature undoubtedly does much to check the progress of disease. As the result also of chronic inflammation, the

bony parietes of the infected cavities may become thickened and sclerosed, thus offering a formidable barrier to the spread of pathogenic invasion.

Extradural Abscess.

By the term 'extradural abscess' is meant a collection of pus between the dura mater and the underlying bone. The usual sites of such purulent collections, when secondary to suppurative middle-ear disease, are (1) over the tegmen tympani or tegmen antri, and (2) in the neighbourhood of the sigmoid sinus. In this latter situation they are frequently associated with thrombosis of the lateral sinus. Extradural abscesses occur fairly frequently in association with acute septic otitis media, but more usually in association with chronic suppurative processes. In an analysis of twenty uncomplicated cases, Grunert found that twelve were due to acute suppuration of the middle ear and eight to chronic disease.

In a case coming under the writer's care, and following acute otitis media, suppuration from the middle ear had ceased, and the perforation had cicatrized. The extradural collection was opened, with immediate relief to all symptoms. In cases of this description, several of which have been recorded, the pneumococcus has been found in the pus in great abundance.

In size they vary within wide limits, at times being small and at other times containing several ounces of pus. Frequently their size is limited by sutural lines. The dura mater covering such abscesses gradually becomes thickened, softened, and of the consistency of wet wash-leather. At various points it may become perforated so as to present a sieve-like appearance, or its surface may become studded with buds of œdematous granulation tissue, which may penetrate through the bony erosions previously spoken of, and hang down into the middle ear, or into the cavity of the mastoid antrum. In cases which have lasted some considerable time the purulent collection may erode the underlying bone, and, by the formation of a fistulous opening, point externally in the form of a subperiosteal abscess. Such

abscesses may appear in the squamo-parietal region. The surrounding bone is usually discoloured, and is frequently much softened. An extradural abscess, when situated in the middle cranial fossa, may communicate with a temporo-sphenoidal abscess or with the pia-arachnoid cavity; when around the lateral sinus, with a cerebellar abscess.

Symptoms.—Pain is at first complained of, and from being local, gradually becomes more diffuse, so as to spread over the side of the head. The temperature, which at the commencement of the disease is slightly elevated, becomes ultimately subnormal, and in cases where the collection of pus is large and the increase of intracranial tension great, markedly subnormal. If associated with a concomitant sinus thrombosis, special symptoms are masked by the more severe constitutional disturbance caused by the thrombosis.

Treatment.—The first indication is to treat the septic focus within the middle ear or mastoid area, which is the exciting cause of the extradural abscess. To do this it is necessary to freely explore the antrum and the cavity of the middle ear. By doing so the path along which pus has spread to the interior of the cranium may be found, and should be followed, all softened bone and exuberant granulation tissue being freely scraped away so as to expose the abscess cavity. Any exuberant granulation tissue growing from the dura should be gently scraped, and the raw surface swabbed with strong chloride of zinc solution or pure carbolic acid. The cavity, having thus been thoroughly cleansed, is loosely packed with iodoform or cyanide gauze, and encouraged to fill up with healthy granulation tissue.

Prognosis.—In uncomplicated cases of extradural abscess the prognosis is good. Where there is an associated thrombosis of the lateral sinus or an intracranial abscess, the prognosis is naturally not so good, and where a general suppurative pia-arachnitis has been set up the case must be regarded as quite hopeless.

Subdural Abscess.

As the result of pathogenic invasion the arachnoid membrane may become adherent to the inner layer of the dura

on the one side and to the pia mater upon the other. This soldering together of the tissues by plastic exudation forms a barrier, which prevents the occurrence of diffuse leptomeningitis, and which at the same time tends to resist further microbic invasion from without. Should any access of inflammation take place, purulent degeneration of the tissues may result, with formation of a subdural abscess. This abscess, limited as it is by the adhesions previously spoken of, may by pressure erode the pial layer and set up superficial cerebral ulceration, or, by breaking down the existing adhesions, cause diffuse septic leptomeningitis.

Such localized abscesses are amenable to surgical interference. Where symptoms indicate their presence, careful search should always be made for any fistulous tract leading into them, such tracts being frequently situated within buds of œdematous granulation tissue protruding from the dura. At other times it may be necessary to incise the dura in order to expose the arachnoid cavity.

Meningitis—(1) Pachymeningitis ; (2) Leptomeningitis.

Meningitis, as a complication of otitis media, is usually suppurative. It may, however, be non-suppurative or tubercular. The symptoms to which it gives rise are of an irritative character, and vary to some extent according to whether the inflammatory process is basal or vertical. Pain is constant and severe, and generally radiates over the head. It may in rare cases be local or unilateral. There is marked intolerance of light and sound, hyperæsthesia of the skin and muscles, muscular twitchings or rigidities, retraction of the head, stiffness of the muscles of the neck, great restlessness, and frequent convulsions. Vomiting of the cerebral type is an early and distressing symptom. In uncomplicated cases the temperature is usually high, and remains so. The pulse is quick, full, and soft, except in the later stages of the disease, when it becomes very weak and rapid. Tache cérébrale may or may not be present.

As the disease advances, these symptoms are all intensified,

the patient becoming at times quite maniacal. Optic neuritis may or may not be present. It is more common in basic than in vertical meningitis. The pupils, at first contracted, gradually become dilated, sluggish, and often unequal and immobile. Strabismus is frequent, ptosis occasional, and nystagmus rare. As the disease progresses, delirium supervenes, whilst paresis or paralysis of certain muscles or groups of muscles is not uncommon.

The mental condition of the patient also becomes affected, wild delirium, constant chattering, and great irritability being present. From this state the patient passes into one of coma, the pulse becoming small, irregular, and rapid, the respirations shallow and of the Cheyne-Stokes type, and the temperature high. Incontinence of urine and fæces, low muttering delirium and occasional convulsions foreshadow the end.

Some writers attach considerable importance to what is known as Kernig's sign. When the patient is seated upon the edge of the bed, it will in cases of meningitis be found very difficult, if not impossible, to extend the leg upon the thigh, owing to the strong contraction of the flexor muscles.

Examination of Cerebro-Spinal Fluid.—In many cases of intracranial disease following otitis media suppurativa, it is extremely difficult to come to an exact diagnosis. One lesion may complicate another, and the symptoms of one affection may simulate those of another. An analysis of the cerebro-spinal fluid is frequently of value in differential diagnosis. Normally, this fluid, whose specific gravity is 1010 or less, contains either no albumin, or at most a mere trace. In cerebral abscess the quantity of albumin is slightly increased, whereas in meningitis it is markedly so. The presence of more than 1 per cent. of albumin is held to be pathognomonic of the presence of meningitis. The presence of pus or broken-down leucocytes in the escaping fluid is diagnostic, whilst bacteriological examination may reveal the organisms present—*e.g.*, streptococcus, tubercle bacillus, etc.

To perform lumbar puncture, the skin of the region to be operated upon must be thoroughly cleansed and rendered

aseptic. When the patient has been anæsthetized, an aspirating needle of medium size should be thrust through the intervertebral space between the third and fourth or fourth and fifth lumbar vertebræ, the puncture being made exactly in the middle line.

At a depth varying from 2 to 8 centimetres, the needle will enter the spinal canal. The fluid, if under great tension, will spurt out; if not, it will exude drop by drop. It should be at once analyzed, and cultures prepared. When the needle is withdrawn, the puncture should be antiseptically sealed up.

In suppurative leptomeningitis the course of the disease is usually more acute than in pachymeningitis, is attended by more severe symptoms, and if diffuse, is invariably fatal. In pachymeningitis on the other hand, the process may be localized, may be associated with an extradural abscess, and may run a slower and less severe course. The prognosis is also better, recovery frequently taking place.

Both pachy- and lepto-meningitis are frequently associated with other lesions—*e.g.*, abscess, thrombosis, etc.—and the symptoms of the one may mask those of the other. Thus in thrombosis the rapid and severe oscillations of temperature mask the temperature of the meningeal attack, whilst if associated with a large extradural collection of pus the pain may be mainly local and the temperature normal or sub-normal owing to the increasing intracranial pressure and consequent depression of the vital centres.

Cases of acute diffuse leptomeningitis may prove fatal within from a few hours to a few days. The severity of the infection and the site of the lesion materially modify the course of the disease.

Treatment.—If localized and associated with an extradural abscess, free drainage should at once be secured by tapping the abscess cavity and irrigating it thoroughly with antiseptic solutions. Œdematous granulation tissue sprouting from the dura should be gently scraped, and pure carbolic acid or strong solutions of chloride of zinc (grs. xx. to xl. to ʒi.) applied to the raw surface, whilst all diseased bone in the neighbourhood should be removed with a Volkmann's spoon.

The cavity should be then packed with an antiseptic gauze, and the usual dressings applied.

In diffuse leptomeningitis little or nothing can be done beyond the use of palliative measures. The application of ice to the head, mustard to the nape of the neck, and the withdrawal of blood by means of leeches, undoubtedly gives relief for a time. Large doses of iodide of potassium or of quinine and injections of antistreptococcic serum (when by means of lumbar puncture the streptococcus has been proved to be the organism present) should be tried. The bowels should be kept well open by some mercurial preparation, and a light and easily digested diet ordered.

Where plastic exudation has cemented the meshes of the pia-arachnoid firmly to one another, the process may become localized. In such cases a very careful search should be made for any fistulous tract leading through the dura mater into the subarachnoid cavity, and if found should be freely opened up, the cavity thus exposed being cleansed and lightly packed. A concomitant superficial suppurative encephalitis could be reached in this same way and antiseptically cleansed.

Intracranial Abscess.

Intracranial abscesses secondary to ear disease are most frequently met with in the lateral lobe of the cerebellum and in the temporo-sphenoidal lobe, and usually in close proximity to the septic focus within the ear, to which they owe their origin. They are twice as frequently met with in the cerebellum as in the cerebrum, and when so situated are at times associated with an extradural abscess around the sigmoid sinus or with thrombosis of the sinus itself. Both cerebral and cerebellar abscesses are more common on the right side than on the left. They are also, although rarely, found within the pons Varolii, the crus cerebri, and the occipital or frontal lobes.

Usually only one abscess is found. Occasionally however, they may be multiple, and at times one abscess may be found within the cerebrum and another within the cerebellum. In a few instances an abscess has been found to

have developed upon the side opposite to that upon which the ear disease is present.

An intracranial abscess may lie latent for a considerable period of time, and may only be stirred up into activity by some such exciting cause as a blow or a fall upon the head, etc.

It is important to note that the abscess is usually situated in close proximity to the septic lesion within the middle ear or mastoid cells to which it owes its origin, and at times this abscess cavity may communicate by means of a carious aperture through the tegmen tympani or antri with the cavity of the middle ear. Occasionally abscesses have been known to have completely drained themselves along such tracts. Where the abscess is situated at some distance from the initial lesion within the middle ear—a healthy layer of brain tissue intervening—the pathogenic infection will be found to have been carried along vascular or lymph sheaths running between the middle ear and the interior of the brain substance. At times the dura mater in the neighbourhood of the abscess cavity will be found adherent to the underlying bone, or in a state of necrosis, and sometimes perforated.

Certain symptoms are common to intracranial abscess in whatever part of the brain it may be situated, whilst other symptoms are of great value in differential diagnosis, and serve to indicate the position of the abscess cavity. Unfortunately, it is by no means always possible to determine its locale; hence a minute study of the condition of the middle ear and its adnexa, and of all available symptoms, is necessary before coming to any definite conclusion upon this point.

General Symptoms.—Pain is a symptom which is always present, and which is usually severe and continuous. It may be situated over the abscess cavity, but more frequently it is not, and its situation cannot, in most cases, at any rate, be regarded as of any real localizing value. It may intermit for a time, but more usually lasts throughout the whole course of the disease. It may be increased by pressure, and more especially by percussion over the suspected area.

Temperature.—In the acute stages of abscess formation the temperature is considerably elevated. Later on it falls, and usually becomes subnormal (Fig. 133). It may, and usually does, remain subnormal in uncomplicated cases. Should meningitis coexist, or should the abscess rupture into a ventricle or into the pia-arachnoid cavity, it becomes markedly elevated, and remains so until the end.

The Pulse-rate.—In the initial stages of the disease the pulse is rapid, but as pus forms and as intracranial pressure

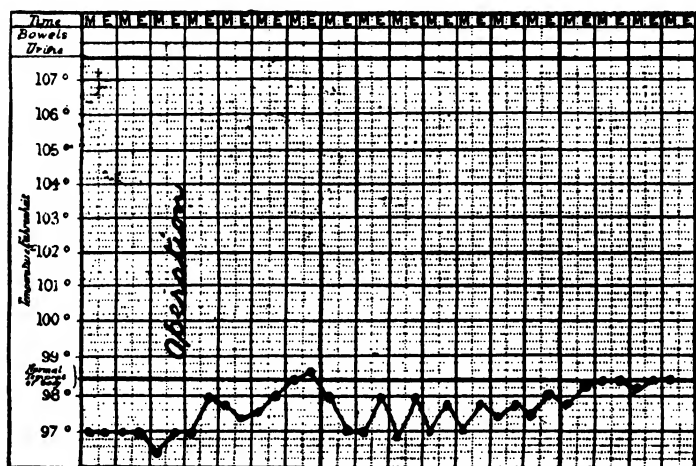


FIG. 133.—TEMPERATURE IN A CASE OF TEMPORO-SPHENOIDAL ABSCESS.
OPERATION. RECOVERY.

increases, it becomes slower and slower, and may not exceed 40 beats per minute.

Respiration.—As intracranial pressure increases, the respiration rate becomes slower, and may not exceed 12 per minute. In abscess of the cerebellum, paralysis of respiration may suddenly supervene, and cases have been known where all respiratory movement has ceased some time before the heart's action has given out. Cheyne-Stokes' respiration is by no means infrequent in such cases.

The Digestive System.—The tongue is coated with a thick fur, the teeth are often covered with sordes, and the breath

is consequently foul. Nausea and vomiting are very common, the vomit being usually of a bilious type, and quite unconnected with the partaking of food (cerebral vomiting).

In cerebellar abscess vomiting is prone to be particularly distressing. Constipation is a marked feature, and the abdominal wall is usually much indrawn and flattened. Rapid inanition is at times a marked feature of the disease.

Eye Symptoms.—In the early stages of abscess formation photophobia is complained of, and the pupils are usually small and contracted. In the later stages of the disease they are frequently unequal, one being dilated, the other contracted and irresponsive to light. In cases of temporo-sphenoidal abscess, paralysis of the third nerve is not uncommon, leading to such symptoms as ptosis, loss of accommodation, downward and outward movement of the eyeball, etc. Optic neuritis may or may not be present. In an analysis of 635 cases of intracranial disease following otitis media suppurativa, Gradenigo (*Annal. des Mal. de l'Oreille*, December, 1898) found 172 cases where an ophthalmoscopic examination had been made. Papillitis was present in 41 per cent. of uncomplicated cases of extradural abscess; in 59·6 per cent. of cases of sinus thrombosis, with or without an accompanying extradural abscess; in 57·9 per cent. of cases of cerebral abscess, simple or complicated with sinus thrombosis; in 60 per cent. of cerebellar abscesses, simple or complicated with sinus thrombosis; and in 48·9 per cent. of cases of leptomeningitis, simple or complicated with sinus thrombosis.

Papillitis is thus most frequently met with in cases of cerebellar abscess and septic thrombosis, and least frequently in cases of extradural abscess.

Drowsiness.—As intracranial pressure increases, the patient becomes more and more drowsy, and his mental faculties more and more blunted (slow cerebration). If roused from this state of lethargy to answer a question, the answer is given, as a rule, correctly, but with great deliberation and effort. In the middle of the answer, the patient may lapse into a state of torpor. His wish is apparently to be left

MOTOR TRACTS

alone to dose, although actual sleep is, as a rule, denied him. From this condition he may pass into deep coma, from which it may not be possible to rouse him.

Paresis and Paralysis.—As has been already remarked, the third nerve may be implicated in temporo-sphenoidal abscess, leading to such symptoms as ptosis, external strabismus, fixed and dilated pupil, etc.

The seventh nerve may be implicated in its course through the middle ear, leading to paralysis of the same side of the face; if implicated cortically, the paralysis is upon the side of the face opposite to the existing ear lesion, and is usually only partial, whilst the sense of taste in the anterior two-thirds of the tongue is unaffected.

Paralysis of the eighth nerve is frequently found in cases of cerebellar abscess.

Aphasia, either motor or sensory, may be present. Motor aphasia may be due either to direct pressure upon Broca's convolution when the abscess cavity is situated within the left temporo-sphenoidal lobe and well forwards, or to pressure upon the conducting paths from the cortex through the internal capsule or corpus callosum; sensory aphasia when the abscess is situated upon the left side, and in the upper and posterior part of the first temporo-sphenoidal convolution.

Paresis of the muscles of the arm or leg of the opposite side of the body is fairly frequent; complete hemiplegia is rare.

The accompanying scheme (a vertical section of the temporo-sphenoidal lobe) shows the motor tracts from the cortex to the periphery.

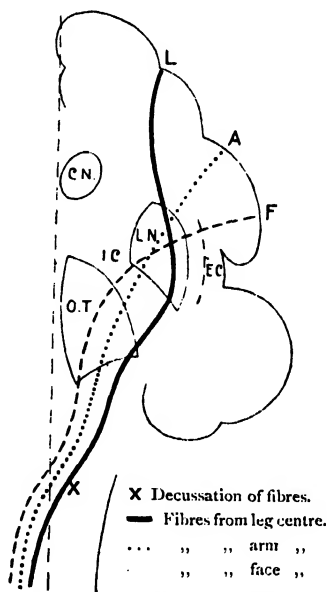


FIG. 134.—MOTOR TRACTS.

In certain cases the hemiplegia or hemiparesis is due to direct pressure upon the motor tracts; in other cases to actual implication of the motor paths in the morbid process.

When the paralysis is of cortical origin, the face centre is the one first affected, then the arm and leg. When of capsular origin, the order is exactly reversed.

Temporo-Sphenoidal Abscess.—*Special Localizing Symptoms.*—These may be arranged as follows:

1. Paralysis of third nerve, with oculo-motor phenomena.
2. Paresis or paralysis of opposite side of body of cortical or capsular origin.
3. Convulsive seizures, beginning upon the opposite side of the body and finally becoming general.
4. Exaggerated tendon reflexes of opposite side.
5. Motor aphasia (occasional).
6. Sensory aphasia (occasional).
7. Cutaneous anæsthesia of opposite side of body.

Cerebellar Abscess.—*Special Localizing Symptoms.*—

1. Recent researches by Risien Russell tend to show that a certain control over the muscular movements of the same side of the body is exercised by the cerebellar lobes. In cases of abscess there is frequently found some inco-ordination in these movements—*e.g.*, a tendency to fall to the side opposite to that upon which the abscess is situated, a tendency to fall forwards or backwards, etc.

2. In some few cases brachial or crural paralysis or paresis has been observed where the abscess has been situated medially, and has been exerting pressure upon the upper regions of the spinal cord or the dentate nucleus.

3. Occipital pain of an unusually severe character is frequently present in cerebellar abscess, and is generally much increased by percussion. Marked retraction of the head is worthy of note.

4. Severe vomiting and frequent yawning are more common in cerebellar than in cerebral abscess, and tend to produce the marked prostration of the patient which is such a prominent feature.

5. Papillitis is more frequently present in cerebellar abscess than in any other form of intracranial complication.

6. Conjugate deviation of the eyes to the opposite side, and nystagmus towards the same side, are important symptoms.

7. The knee-jerk upon the same side may be exaggerated.

8. Nerve deafness is frequently present. Cutaneous sensibility is unaffected.

9. The position assumed by the patient as he lies in bed is typical—viz., curled up, with flexed limbs and upturned face.

Treatment of Intracranial Abscess.—When a diagnosis of the existence of an intracranial abscess has been made, no time should be lost in attempting to evacuate the pus. Minute care should be bestowed upon the general preparation of the patient and upon the preparation of the operation area.

General preparations consist in the administration of a dose of opening medicine, light, easily-digested food, and, if need be, one or two teaspoonfuls of brandy just prior to the operation.

Local Preparation.—The hair for several inches round the part to be operated upon is to be shaved, and the scalp well washed with soap and water. Turpentine should then be freely used, and finally the whole operative area scrubbed with ether, so as to effectually remove all grease, etc. The head should then be wrapped up in lint soaked in a glycerine solution of perchloride of mercury (1 : 1,000), or of carbolic acid (1 : 40), and covered with rubber tissue.

The room in which the operation is to take place should be well heated.

Anæsthesia.—Experience has shown that chloroform is the anæsthetic *par excellence* for these cases. It should be administered carefully and slowly. Should paralysis of respiration threaten, or actually take place, the operation should be proceeded with as quickly as possible whilst artificial respiration is kept up.

The first step in the operation, except under very exceptional circumstances, is the opening up and the inspection of the cavity of the middle ear and adjoining mastoid antrum and cells. By means of a good search-light, it may be pos-

sible to discover a fistulous tract in the bone which communicates with the abscess cavity, and along which pus is oozing. In such cases the tract should be enlarged by means of a sharp spoon, so as to secure free drainage. The abscess cavity may subsequently be exposed by external operation, and thorough drainage established.

The incision through the soft parts should be semicircular, so as to produce a good-sized flap with its base uppermost. All bleeding-points should now be secured and tied. In mapping out the point at which the pin of the trephine is to be applied, it should be borne in mind that almost all intracranial abscesses develop in close proximity to the exciting septic lesion within the middle ear, and that to secure efficient drainage the opening into the abscess cavity should be made so as to, as nearly as possible, drain the abscess at its lowest level.

A trephine of from five-eighths to three-quarters of an inch in diameter, and with its cutting edge outside (Horsley, Cotterill)

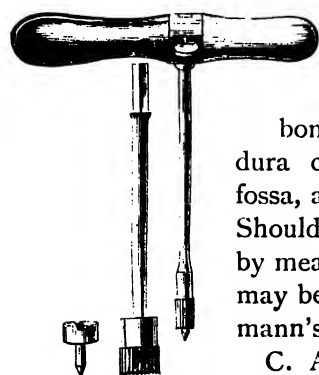


FIG. 135.—TREPHINE.

(Fig. 135), should be used, and its centre pin placed at a point seven-eighths of an inch above the suprameatal spine. The disc

bone thus removed will expose the dura covering the base of the middle fossa, and the tegmina antri et tympani. Should sufficient bone not be cut away by means of this trephine opening, more may be removed by cutting forceps (Hoffmann's), Cryer's drill or burrs.

C. A. Ballance advocates removing a parallelogram of bone $1\frac{3}{4}$ inches antero-posteriorly and 1 inch vertically, the lower edge of the parallelogram corresponding with the lower edge of the trephine opening, whilst three-quarters of an inch of its antero-posterior extent should lie behind the centre of this aperture and 1 inch in front. Ample room is thus secured for dealing with the abscess cavity, and for inspecting and treating, if necessary, the roof of the middle ear and mastoid antrum.

The same principle—that of making a large bone aperture—should be employed when searching for cerebellar abscess. A five-eighths of an inch trephine should be placed so that its anterior edge touches the posterior border of the mastoid process, and its upper edge lies just below Reid's base line. The disc of bone thus removed will expose the anterior part of the cerebellar lobe, and possibly the edge of the vertical portion of the sinus. The opening is most advantageously enlarged in a backward direction, and should be so enlarged as ultimately to measure from $1\frac{1}{4}$ to $1\frac{1}{2}$ inches antero-posteriorly and 1 inch vertically.* As it is somewhat difficult to remove bone after the dura has been incised and the brain cortex possibly bulging, it is advisable to see that all the bone which it is necessary to cut away is cut away before the soft parts are inter-

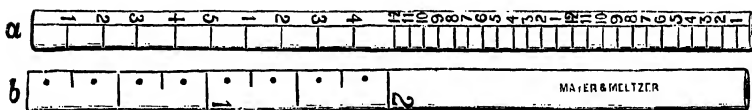


FIG. 136.- RULE WITH SCALE (MACNAUGHTON-JONES).

fered with. The dura should be incised by means of a sharp knife, the line of incision being crescentic with its base uppermost. If an abscess is present, marked bulging through the opened dura will at once take place.

In certain cases, and when the abscess is just under the cortex, its situation may be revealed by palpation. In most cases it will have to be searched for with the aid of such instruments as pus-searchers, trocar and cannula, grooved director, knife, etc. Care should be taken, whichever instrument is used, that in introducing it through the cerebral cortex no vessels are wounded. The main objections to the use of pus-searchers or cannulæ are that, even if they do penetrate the abscess cavity, the pus may be so thick as not to flow, or, on the other hand, the instrument may fail to penetrate the capsule, or, if it does penetrate it, may pass completely through the cavity.

* This rule (Fig. 136) will be found useful for measuring these distances upon the skull. The flat bone index that accompanies it indicates the estimated distances of the dura mater from the surface, and the points of attack by the trephine.

The best searcher is the blade of a long flat knife passed through the cortex in the direction of the supposed abscess cavity. Should pus be struck, a fine pair of sinus forceps should be passed parallel to the blade of the knife, and opened when within the abscess cavity. In this way pus will readily escape, and before the forceps are removed a rubber drainage-tube of sufficient calibre should be introduced. Some surgeons prefer decalcified chicken-bone drainage-tubes or silver tubes. Rubber drainage-tubes will, as a rule, be found the most serviceable and the easiest of adaptation. After all pus has escaped, the cavity may be washed out with normal sterilized saline solution or weak carbolic lotion (1 : 40). To secure free exit for the lotion, irrigation should be conducted through a small tube attached to a syringe, one half or one third of the diameter of the tube which is *in situ*.

In acute abscesses irrigation is both unnecessary and inadvisable ; in chronic abscesses, where there is a thick capsule, it is useful, and should be employed. The drainage-tube should be left *in situ* for days, and should only be shortened when the abscess cavity, as the result of the healing process and consequent contraction, tends to push it outwards. An opening must be cut in the flap, and the tube drawn through and retained by sutures. The wound is now to be thoroughly cleansed with warm 1 : 1,000 bichloride of mercury solution and the soft parts sewn up. In exceptional cases, as, for instance, where there has been a concomitant superficial encephalitis, it may be deemed more prudent to avoid suturing the soft parts. Cyanide or iodoform gauze dressings are then to be applied.

After-treatment.—The patient should be kept perfectly quiet in a darkened room, and fed upon light easily-digested food. Should sickness persist, probably nothing is better than hot water given in large quantities and frequently. Constipation should be combated by gray powder, calomel pills, enemata, etc. The state of the dressings, the temperature, and the pulse-rate are the best indices of the patient's condition. If possible, the dressings should be left undisturbed for several days.

In cases where drainage is not satisfactory, and where

there is a re-accumulation of pus, pain will again become a prominent symptom, and will be associated with signs of cerebral irritation, falling temperature and pulse-rate. Under such circumstances, the dressings should at once be removed, and, if necessary, the wound reopened. It is possible that a second abscess may exist within the brain. Should the symptoms continue in spite of efficient drainage from the abscess first tapped, careful exploration should be made with the finger for any tense swelling within the brain substance. On the other hand, an acute abscess may form after evacuation of the original abscess, as indicated by rapid rise of temperature, pain, restlessness, delirium, retraction of the head, etc., and call for immediate treatment. When all pus has ceased to flow, the drainage-tube should be removed and the wound allowed to close.

In certain cases a hernia cerebri may develop and cause great trouble. Whether due, as maintained by some, to sepsis, or by others to altered intracranial tension, it requires careful handling. Graduated pressure by means of antiseptic dressings, elastic bandages, or thin sheets of sterilized lead, may be tried, or more bone may be cut away, so as to relieve tension. Shaving off portions of the protruding cortex should be avoided.

Where doubt exists as to the exact situation of the abscess, Percy Dean has proposed placing the pin of the trephine 1 inch behind and a quarter of an inch above the external auditory meatus. By removing a disc of bone in this situation, it is possible to explore both the temporo-sphenoidal and the cerebellar lobes, whilst Arthur Barker states that an opening made 1 inch above and behind the centre of the external auditory meatus will enable a careful search of the whole temporal lobe to be made.

Septic Thrombosis of the Sigmoid Sinus.

In cases of old-standing purulent middle-ear disease, ulceration of bone may extend until the groove of the lateral sinus is opened up. An extradural abscess is thus prone to form around the sinus and to lead to an inflammation of its walls.

As a result of this a phlebitis of the sinus is set up, ending in the formation of a thrombus. This thrombus rapidly becomes septic, and tends to occlude the blood-stream. In course of time, as the result of the action of micro-organisms, the thrombus becomes softened, broken up, and disintegrated. Detached particles are carried away to distant organs by the general blood-stream, there to set up embolic metastatic abscesses.

In other cases the minute venous radicles which ramify between the mucosa of the mastoid cells and the walls of the lateral sinus become infected and thrombosed, and are the means of conveying septic organisms from the primary focus of suppuration to the interior of the sinus, there to set up a septic inflammation of its walls with secondary thrombosis. In yet other cases the bulb of the jugular vein, lying as it does in close contiguity to the floor of the middle ear, becomes infected as the result of septic disease within the tympanic cavity.

Symptoms.—The most important symptom of the presence of lateral sinus thrombosis is the occurrence of repeated rigors. At first these rigors may be slight, and at intervals of hours or even days, but as the septic process invades the system, they become much more frequent and severe. The temperature rapidly rises from a normal or even a sub-normal state to 103° or 105° F. Such rapid oscillations of temperature (Fig. 137) are characteristic of thrombosis. Profuse sweating follows as the temperature begins to fall. During the height of the rigor the patient's teeth chatter, and the bed upon which he lies is audibly shaken. The pulse, which in the early stages of the disease is rapid and full, gradually becomes slower and softer as the septic intoxication increases. Headache is always complained of, and as a rule is general. If intracranial abscess or meningitis co-exist, it is severe and continuous. Local pain is also as a rule present, and may be elicited by pressure over the sinus or by deep pressure over the upper part of the posterior cervical triangle. In cases where the thrombotic process invades the jugular vein in the neck, pain is complained of along its course.* In such cases the vein may be felt as a hard indurated cord in the

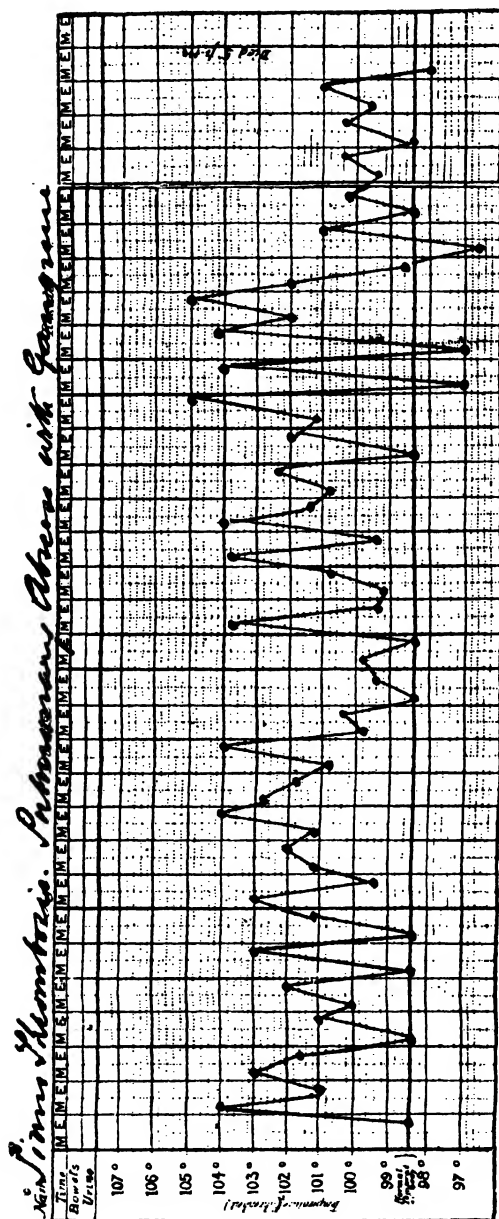


FIG. 137.—TEMPERATURE IN A CASE OF SINUS THROMBOSIS. PULMONARY ABSCESS WITH GANGRENE.

neck, painful on pressure. The lymphatic ganglia about the angle of the jaw are prone to become enlarged and tender, and in advanced cases may break down, forming deep-seated abscesses. Owing to the obstruction to the outflow of blood through the mastoid and other emissary veins, the superficial tissues over the mastoid and occipital areas frequently become œdematous. This is known as Griesinger's sign.

In course of time minute particles become detached from the thrombus, and are carried by the general blood-stream to distant organs, there to become lodged and to set up embolic septic abscesses. The organs most frequently implicated are the lungs, the pleuræ, the brain, the kidneys, liver and spleen. Metastatic abscesses may also develop in any of the larger joints or in muscles. General pyo-septicæmia is thereby induced, with all its attendant risks and dangers.

Special Pulmonary Symptoms.—When a minute embolus becomes detached and lodged within the pulmonary tissues, a patch of septic pneumonia is produced. This tends to spread rapidly until the whole lobe, and even the whole lung, becomes implicated. The patient's temperature keeps elevated; he is troubled with a constant hacking cough, and expectorates considerable quantities of blood-stained secretion. The septic process may be so acute as to destroy the surrounding lung-tissue and to produce a gangrenous form of pneumonia. The breath now becomes extremely foetid, the expectoration profuse, foetid, and blood-stained, whilst small portions of broken-down and necrotic lung-tissue may be brought up. Where the pleura is involved great pain is complained of, and the movements of respiration are performed with difficulty. Considerable effusion into the pleural cavity may take place, with consequent dyspnœa.

Treatment.—In the treatment of sinus thrombosis of septic origin immediate steps must be taken to prevent the dissemination of infected particles of clot to distant parts of the body. This object is best attained by exposing the sinus, clearing out the thrombus, and either packing its proximal end or tying the internal jugular vein in the neck.

By so doing, the main channel along which septic emboli

travel to the heart, and thence to more distant organs, is occluded.

The sinus may be reached (1) by a backward extension of the opening made to expose the mastoid antrum, its knee being usually found half an inch behind the centre of the posterior wall of the antrum; (2) by placing the pin of a trephine upon Reid's base-line half to three-quarters of an



FIG. 138.—RADIOGRAM SHOWING COURSE OF SINUS AND TREPHINE OPENINGS OVER TEMPORO-SPHENOIDAL LOBE AND CEREBELLUM.

inch behind the centre of the posterior wall of the external auditory meatus and removing a disc of bone; (3) by removing a disc of bone as recommended by P. Dean, as done in suspected cases of intracranial abscess (p. 237).

In certain cases pus will be found around the sinus (extradural abscess) without any thrombosis existing. Palpation will at times reveal the presence of a thrombus. The absence of all movement during respiration is an important sign, but the most definite information is gained by exploration with a hypodermic needle. A carefully-sterilized needle is passed

into the sinus. If no blood be withdrawn, the existence of a thrombus is established. On withdrawal, the needle frequently has a foetid smell. In certain cases, owing to the lumen of the sinus not being completely obliterated, blood is withdrawn, and is usually foetid. Occasionally pus may be drawn into the syringe.

It having been ascertained that the sinus does contain a septic clot, from three-quarters of an inch to 1 inch of the bone covering the sinus in the direction of the torcular Herophili should be removed by bone forceps, so as to give ample room for farther manipulation. The sinus is now to be slit up in a backward direction, and the thrombus scraped out by means of a sharp spoon until there is a free flow of blood from its distal end. The sinus should now be packed with strips of iodoform gauze well dusted with iodoform and boracic powder (1 to 4), or its outer wall may be folded inwards against the inner wall and kept in position by gauze tampons. The proximal end of the sinus is now scraped until blood is seen to regurgitate through it.

It is necessary to decide whether or not to expose and ligature the internal jugular vein in these cases. Upon this point considerable difference of opinion exists. The indications, as defined by Whiting (*Arch. of Otolog.*, February, 1898) are worthy of study in this connection.

I. Indications for tying the jugular before exposing the sinus:

- (a) The existence of chronic otorrhœa.
- (b) Pronounced manifestation of pyo-septicæmia.
- (c) Metastases.
- (d) Occipital œdema (Griesinger's symptom).
- (e) Œdema of eyelids of same side.
- (f) Tenderness along the course of the jugular in the neck.
- (g) A cord-like feeling of the infected vein.
- (h) Commencing neuro-retinitis.

II. Indications for ligature after exposing the sinus and recognising the thrombus, but before opening it:

- (a) The presence of a clot extending well down into the bulb and disintegrated in its lower portion (as

indicated by aspirator) associated with distinct pyæmic symptoms, although metastases are absent.

- (b) The display by the sinus of respiratory movements would render probable the admission of aerial embolism to the heart unless the vein were first tied.

III. Indications for ligation after exposing and opening the sinus:

- (a) The presence of a large thrombus extending down into the bulb, and having undergone purulent liquefaction in the deep bulbous portion, which may not have been diagnosed until the sinus was extensively opened.
- (b) Inability to re-establish the circulation from below, whether the clot has or has not disintegrated, and whether or not there has been tenderness in the neck.
- (c) Inability to re-establish the circulation from either direction has aroused discussion as to the advisability of ligating both jugulars.

In order to expose the vein in the neck, an incision is made from the angle of the jaw to a short distance below the level of the cricoid cartilage along the anterior border of the sterno-mastoid muscle. The skin, superficial fascia, and the platysma muscle are divided. The deep cervical fascia is now exposed and divided. The sterno-hyoid and sterno-thyroid muscles are drawn aside by means of retractors, and the carotid sheath is thus brought into view and then opened. An aneurism needle is passed round the vein from the outside, great care being taken to avoid injuring the vein, and including the vagus nerve. Two ligatures are put on in this way, and the vessel is divided between them.

If desirable, the upper ligature may be removed, and irrigation made through the mastoid wound. The open end of the vessel may either be stitched to the skin, or, if retied, the ligature should be removed within a couple of days, so as to avoid the risk of the vessel becoming a reservoir

for sepsis. If a bacteriological examination of the contents of the sinus has been made, and streptococci are the organisms present in greatest abundance, injections of anti-streptococcic serum may be employed. Owing to the fact that ligation of the internal jugular vein does not entirely shut off the blood-stream from the infected area to the heart and lungs, its employment may be of material advantage in severe septic intoxication. The condylar veins, both anterior and posterior, the occipital sinus, and to a less degree the petrosal sinuses, may transmit infected particles to the sub-clavian vein and thence to the general circulation.

Liberal diet and stimulants are requisite to counteract the depressing influence of the systemic poisoning. Quinine in large doses, turpentine (grs. v. to x. in capsules), and ammonia with bark, are all useful. Secondary metastatic deposits must be treated upon general principles.

Prognosis.—If the patient be seen and operated upon in the first week of the disease, the prognosis is good; if in the second week, the outlook is not so favourable, and if in the third week, the prognosis is essentially bad, the patient by this time being saturated with poison, and metastatic deposits in various organs having usually taken place.

The occurrence of metastatic deposits, although naturally of serious import, should not necessarily preclude the idea of operative interference.

Otitic Osteophlebitic Pyæmia.

Most cases of otitic pyæmia are associated with thrombosis of the sigmoid sinus, and the dissemination of infective material throughout the system. In certain cases no thrombosis is present, the pyæmic symptoms being due to the direct absorption of pathogenic organisms into the blood-stream. Such cases are usually acute in character, the septic process being, in the first place, at any rate, confined to the soft tissues. Metastatic abscesses are common, and are most frequently found in distant parts of the body—the larger joints, the pleural cavities, subcutaneous tissues, and muscles.

Visceral metastases are not so common as in pyæmia of thrombotic origin, nor do the deposits show the same tendency to pus formation. When joints are implicated, there is frequently only serous effusion with pain. In the same way serous effusion may take place into the muscles, especially those of the calf and shoulder, and become absorbed without suppuration ensuing.

Pyæmia of osteophlebitic origin runs a more favourable course than that due to thrombosis, and offers a better prognosis.

Treatment.—If in any case of acute suppurative middle-ear disease with an efficient outlet for any purulent collection pyæmic symptoms supervene, and especially if any indication exists of implication of the mastoid area, the antrum should be opened, so as to facilitate drainage and to permit of free irrigation with antiseptic solutions. Should recurring rigors take place, the groove for the sigmoid sinus should be exposed and the sinus examined. If a thrombus be found, it must be dealt with upon the principles already indicated (p. 242). Even if no clot be found, it is recommended by some surgeons—*e.g.*, Ballance, Deanesly—that the vein be ligatured and the sinus plugged. In one of the writer's cases of osteophlebitic pyæmia, with effusion into the left pleural cavity and left gastrocnemius muscle, the sinus was exposed, opened (no clot was found), and packed, with a satisfactory result.

In chronic suppurative otitis media, with recurring rigors with or without metastatic deposits, the sinus should at once be exposed and examined for a thrombus.

Caries and Necrosis of the Temporal Bone.

In many cases of suppurative disease of the middle ear and its adnexa, the mucosa, which is also the muco-periosteum of the part, undergoes ulcerative changes, which lead to exposure of the underlying bone and subsequent caries or necrosis. The cancellous tissue of the mastoid cells is prone to be affected in this way, whilst the denser portions of the bone, the cortex, the pars petrosa, etc., are more

likely to become necrotic. Caries is especially common in the chronic otorrhœa of children, whilst necrosis is frequently met with in acute affections of the middle ear. Both processes may go on at the same time, with the result that a cavity is produced within the mastoid process, in which may be found a sequestrum or sequestra of varying size. In tubercular cases there is a peculiar liability to necrosis, and large portions of the temporal bone are shed in this way. In the labyrinth the destructive process may end in exfoliation of the whole or part of the cochlea, of portions of the semi-circular canals, etc.

Caries is at times met with upon the inner wall of the middle ear, with the result that the labyrinth becomes invaded by pathogenic organisms, and a direct path is thus afforded for their transference along the sheaths of the seventh or eighth nerves to the base of the brain and to the cerebellum. In suppurative affections of the epitympanum, the outer attic wall and the ossicula auditûs are peculiarly prone to become diseased. The outer wall may become detached in the form of a sequestrum, the morbid process performing, as it were, a natural Stacke's operation. Within the mastoid area this destructive process may advance to such an extent as to lay bare the dura of the posterior fossa and the groove of the lateral sinus. In the majority of cases the tendency of the disease is to spread to the exterior, with the ultimate formation of a mastoid fistula (Fig. 139), and possibly also of a subperiosteal abscess. The absorption of the bony septa, as the result of mastoid caries, may lead to great enlargement of the mastoid antrum and of the cavities of the middle ear, whilst, on the other hand, the same cario-necrotic process may lead to the formation of dense cicatricial tissue, which ultimately becomes bony, and which may cause obliteration of the mastoid cells and marked stenosis of the external auditory meatus. In order of frequency, the parts most prone to become diseased are the mastoid process, postero-superior wall of the external meatus, the roof of the tympanum, its floor, and its inner wall.

Symptoms.—When bone disease is present the discharge is

free, foetid, and frequently blood-stained. If rubbed between the fingers particles of grit may be felt, and if microscopically examined bony spicules may be found. Exuberant granulations of a soft and flabby consistence form, as it were, a fringe to the destructive process. If a fistulous tract exists

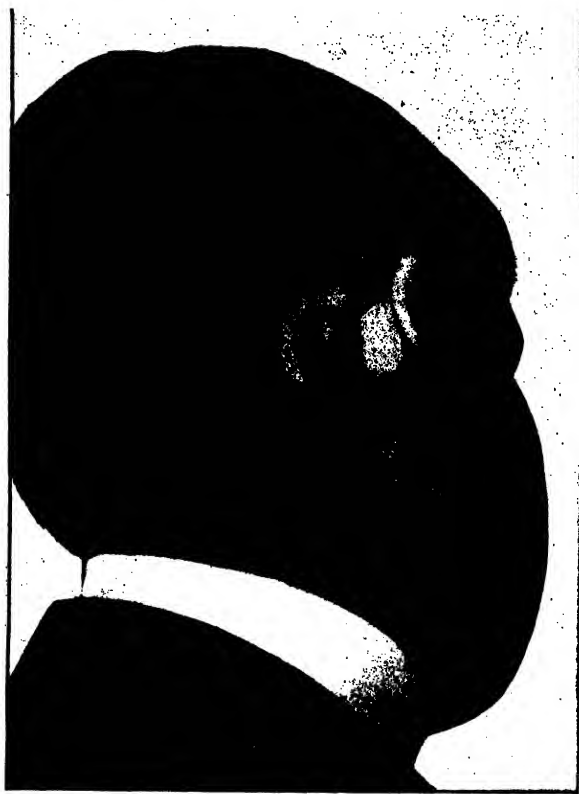


FIG. 139.—MASTOID CARIES. FISTULA. BONE GRANULATIONS.

either in the mastoid cortex or its anterior wall (the posterior meatal wall), a bud of granulation tissue usually marks its site, and of itself should arouse a suspicion of the existence of deep-seated disease within the bone. In other cases the posterior meatal wall will be found to bulge, and to partially occlude the lumen of the meatus. The bulging is due to the

existence of a suppurative periostitis, which demands free incision.

The anatomical position of the facial nerve renders it peculiarly liable to be affected by mastoid and labyrinthine caries; hence facial paralysis is a common symptom, and more especially so in cases of tubercular origin. The periotic ganglia are prone to become enlarged as the result of septic absorption, and at times break down and suppurate. Perversion or abolition of the sense of taste over the anterior two-thirds of the tongue upon the same side as the ear lesion is common. Pain is a very varying symptom. It may be severe, deep-seated, and of a boring character. At other times it may be practically absent. Subjective noises in the head and vertigo are frequent when the labyrinth is affected.

Diagnosis.—The diagnosis of caries or necrosis is in many cases easy, whilst at other times a positive opinion cannot be given unless the patient be watched for weeks or months. Ocular inspection may reveal at once the existence of a sequestrum or of an area of bare bone. Great aid is furnished by the careful use of a suitable probe. The probe should be probe-pointed and of soft metal, and mounted upon a handle at the proper aural angle. By careful palpation areas of rough and bare bone may be felt, or a movable sequestrum may be detected. The area of bone-disease may be so situated, however, under cover of the mastoid cortex as to be inaccessible to examination with the probe. A diagnosis has therefore to be made from the presence of some of the following symptoms:

1. Profuse foetid and occasionally blood-stained discharge.

2. The presence of bony spicules in the discharge.

3. The constant recurrence of granulations after removal.

4. The resistance of the 'disease to careful antiseptic treatment.

5. The presence of fistulæ in the cortex or anterior mastoid wall.

6. The presence of deep-seated boring pain without any objective evidences of tension.

Prognosis will naturally depend upon the extent and the situation of the lesion, and the general constitutional condition of the patient. The larger the sequestrum, the greater the danger, owing to the possibility of important neighbouring structures—*e.g.*, carotid artery, sigmoid sinus, facial nerve, etc.—being exposed. Necrosis of the labyrinth may, from secondary ulceration of the carotid artery, lead to fatal hæmorrhage, whilst from exposure of the seventh or eighth nerves it may afford a path for the transference of septic organisms to the basal meninges or cerebellum. Necrosis of the mastoid cells may lead to perforation of the tegmen tympani and exposure of the dura lining the middle fossa, or to exposure of the groove of the sigmoid sinus and dura lining the cerebellar fossa, whilst necrosis of the tympanic roof may lead to perforation of the tegmen tympani, and of its floor to exposure of the jugular bulb.

Treatment.—Antiseptic treatment, followed out with the minutest care, is essential. Granulations, cholesteatomatous debris, etc., should be thoroughly removed, so as to facilitate drainage and the application of remedial agencies. Instillations of solutions of hydrogen peroxide or of mineral acids (Ole Bull) are at times serviceable. Removal of small sequestra by means of forceps may be accomplished, whilst large sequestra may be broken up by miniature crush-forceps, and removed piecemeal. Areas of caries, accessible by way of the external meatus, may be scraped by means of small curettes or Volkmann's spoons, or touched with chromic, sulphuric, or hydrochloric acid. Those areas which are less accessible should be thoroughly exposed by external operation, and dealt with accordingly.

Attention should at the same time be paid to the general constitutional condition of the patient. In tubercular subjects an open-air life should be advised, with plenty of plain nutritious food, milk, etc. Cod-liver oil, the hypophosphites, quinine, or the syrup of the iodide of iron, are useful. In syphilitic patients mercurial inunctions, iodide of potassium, or arsenic are requisite, whilst in generally debilitated patients good food, rest, and tonics are essential.

Hæmorrhage from the Ear.

As the outcome of chronic suppurative disease within the middle ear or mastoid area, ulceration of bone may extend until the carotid artery, the lateral sinus, or the jugular bulb are exposed. The result may be recurring hæmorrhages, which usually end fatally. The carotid artery, from its close relationship to the inner tympanic wall, is the vessel most usually implicated. As the result of gradual bone ulceration, it becomes exposed usually at the junction of its vertical and horizontal portions in the carotid canal, and subjected to the constant irritation of decomposing pus. Gradual erosion of its coats takes place until perforation ensues. In like manner the knee of the lateral sinus may become eroded in cases of mastoid disease, and the walls of the jugular bulb in caries of the tympanic floor.

Symptoms.—The first indication of danger is the oozing of a little bright-red blood from the external meatus. Soon this oozing gives way to a pronounced flow, the blood spouting from the ear and pouring down through the nose and mouth. Repeated attacks, sometimes at intervals of several days, may take place. At other times the hæmorrhage may be so severe as to cause almost instant death.

Treatment.—If arterial, pressure upon the carotid artery may be tried, or the meatus may be plugged with gauze soaked in gelatine. The common carotid artery should as soon as possible be tied. Owing to the almost invariable recurrence of hæmorrhage (through the circle of Willis), it has been suggested that both common carotids be ligatured.

Where the hæmorrhage is venous, as is indicated by its dark colour, want of pulsation, and the fact of its being uninfluenced by pressure over the common carotid artery, the outlook is more favourable. Packing the meatus, rest, ice to the part, and the internal administration of iron, ergot, turpentine, or sulphide of calcium, may cause its arrest.

CHAPTER X

DISEASES OF THE NOSE AND NASO- PHARYNX IN THEIR RELATION TO EAR SYMPTOMS

By HERBERT TILLEY

THAT an intimate relationship exists between certain aural and nasal affections has for a long time been universally acknowledged. The very common history of deafness originating from 'repeated colds in the head,' and the increase of deafness which occurs in a deaf patient during the continuance of an acute nasal catarrh, are matters of everyday experience.

The practical recognition of such a relationship has been of inestimable value, and cannot be better illustrated than by the frequency with which the cure of deafness or of chronic suppurative otorrhœa follow the removal of post-nasal adenoid growths, or than by the improvement in hearing, or the relief of other aural symptoms which follow the treatment of certain forms of hypertrophic rhinitis.

Nasal and naso-pharyngeal affections may affect the ear in the following ways:

1. By the spread of catarrhal affections from the nasal mucous membranes to the Eustachian tube or to the tympanum, as in acute rhinitis, chronic rhinitis, and naso-pharyngeal catarrh.
2. By occlusion of the mouth of the Eustachian tube by
• a new growth, or pathological enlargement of a normal structure—*e.g.*, adenoids, naso-pharyngeal polypus, moriform hypertrophies of the turbinals. Catarrhal changes are usually associated with such causes, and enhance their effects.

3. In those cases where marked nasal obstruction is present, it is theoretically possible that with each effort to breathe through the nose a diminished atmospheric pressure is produced behind the obstruction, which tends to exhaust the air in the tympanum as well as to induce a compensatory congestion (by blood and lymph) of the nasal, naso-pharyngeal, and tympanic mucosa. Such changes, if long continued, engender a hyperplasia of the mucous membranes involved, and, in the case of the ear, some permanent retraction of the tympanic membrane is a frequent result.

In considering the relationship existing between diseases of the nose and ear, two practical questions demand an answer, viz. :

1. What affections of the nose are liable to induce pathological conditions within the ear.

2. What is the nature of the aural symptoms produced by nasal or naso-pharyngeal affections.

With regard to the first question, it may be said that the ear is most likely to be affected by those diseases of the nose which are characterized by catarrhal swelling of the mucosa, and that this tendency will be enhanced when nasal obstruction is added to the catarrh. It is quite an unsettled question whether nasal obstruction alone is sufficient to induce pathological conditions within the ear. We often meet with complete obstruction of long duration, due to polypi or to a deviated septum, in which the hearing is perfect, and hence we must be cautious, when we find deafness associated with some slight degree of nasal stenosis, not to at once conclude that these conditions stand to one another in the relation of cause and effect.

The common pathological conditions of the nose and naso-pharynx which may be associated with deafness or ear symptoms are : Acute rhinitis, chronic hypertrophic rhinitis, atrophic rhinitis, nasal polypi, deviations of, or outgrowths from, the septum, acute and chronic naso-pharyngeal catarrh, adenoid growths and new growths.*

As to the nature of the ear lesions produced by nasal or naso-pharyngeal affections, it may be said that, generally speaking, they come into the category of moist catarrhs,

and only in such cases is there much hope of remedying the aural complications by intranasal treatment.

Under these circumstances there is usually a history of repeated attacks of catarrh, each one leaving the patient possibly a little deafer than before, and examination of the ear will show some retraction of the membrana tympani, with other evidences of Eustachian obstruction. As a rule, there is marked improvement after inflation of the tympanum by Politzer's method, but this may only be of temporary duration. The same good results are often noted during dry, bracing weather. With the tuning-fork there will be diminished hearing for low-pitch notes, negative reaction to Rinne's test, while the bone conduction is usually normal or even increased.

On the other hand, we may have to deal with deafness of gradual and almost imperceptible onset, often associated with, or preceded by, tinnitus, where the patient hears better in a noise, the drum being practically normal in appearance and position, the Eustachian tube patent, no improvement on inflation of the tympanum, and the tuning-fork gives results similar to those already described in the catarrhal form. Under such circumstances we can hope for very little improvement in the ear symptoms from intranasal treatment, and it is highly problematical whether we can check the progress of the deafness by such means. Our inability to do much for this form of deafness is due to the fact that changes of a (presumably) osteo-arthritic nature are present around the footplate of the stapes and possibly even within the labyrinth. No doubt the general comfort of the patient may be increased by removal of marked nasal stenosis, but the ear symptoms will probably remain the same, or may even be increased by the shock of the operation. In practice the surgeon will often have to deal with cases in which the ear symptoms are due partly to catarrhal and partly to stapedial and labyrinthine changes, and consequently great discretion will be necessary in advising the patient as to how much benefit may be expected from intranasal treatment.

If there be a history of repeated colds in the head, each attack being followed by increased deafness, and if under

ordinary circumstances the degree of deafness varies from time to time, and if in association with such symptoms there be a considerable amount of nasal stenosis, which in itself would seem to render the nasal mucosa liable to catarrh, then it may reasonably be expected that removal of the nasal obstruction will render the patient less susceptible to 'colds,' and so preserve what hearing remains, or, at any rate, retard the rapid progress of the aural symptoms.

When it is doubtful whether intranasal treatment will or will not be followed by improvement in the ear symptoms, the surgeon will least often disappoint both himself and his patient if he be guided by the result of inflation of the tympanum. Nasal obstruction being present, improved hearing following Politzerization would be in favour of intra-nasal treatment, otherwise it would probably avail little except in adding to the general comfort of the individual, although, as already stated, it might possibly, in a few cases, tend to retard the rapid progress of deafness by rendering the patient less liable to nasal catarrh.

In the more acute forms of tympanic inflammation due to septic infection and characterized by a purulent discharge from the meatus, there can be no doubt that occasionally the primary source of infection is derived from a suppurative lesion in one or more of the nasal accessory sinuses—*e.g.*, the maxillary antrum, ethmoidal, frontal, or sphenoidal sinuses. Only in this way can we explain the immediate improvement in certain recorded cases of otorrhœa, which, although failing to respond to the ordinary treatment for that affection, have rapidly cleared up when the suppurative lesion in one of the neighbouring accessory nasal sinuses has been efficiently dealt with.

Nevertheless, it is somewhat remarkable that such an infection of the tympanum is, comparatively speaking, uncommon, and it is the more so when we bear in mind the very septic nature of the purulent discharge which, coming from the nasal accessory sinuses, often bathes the nasal and naso-pharyngeal mucosa for months or years, and leads to the growth of mucous membrane hypertrophies and nasal polypi.

It is for this reason that the writer has thought it unnecessary to describe the symptoms, diagnosis, and treatment of empyema of the nasal accessory sinuses.

The Nose and Naso-pharynx.

The affections of the nose and naso-pharynx which most concern the aural surgeon are :

Acute rhinitis.

Chronic hypertrophic rhinitis.

Atrophic or fœtid rhinitis (*ozæna*).

Stenosis of the nasal fossæ from growths or other causes—*e.g.*, nasal polypi, septal spurs, etc.

Deviations and dislocations of the nasal septum.

Naso-pharyngeal catarrh.

Adenoid growths in the naso-pharynx.

Hypertrophied tonsils.

Acute Rhinitis ('Acute Nasal Catarrh,' 'Cold in the Head').

Causation.—The true exciting cause of acute nasal catarrh is unknown, but the way in which the affection often attacks in rapid succession the various members of a household would suggest that some micro-organism may be the true *materies morbi*.

However that may be, predisposing causes play a very important part in rendering the individual liable to the acute attack. Among these may be mentioned various pathological conditions of the nasal mucous membranes—*e.g.*, hypertrophic rhinitis and various forms of nasal obstruction; exposure of the body, especially the feet, to cold or wet; sudden changes of temperature; nervous exhaustion in any form; bodily fatigue, especially when following free perspiration; and the inhalation of irritating gases, vapours, dust, fog, etc. The internal administration of iodide of potash will, in some individuals, produce symptoms very similar to those of acute rhinitis.

A 'cold in the head' may be the first sign of measles in a child, while in certain epidemics of influenza the onset of

this malady has been characterized by well-marked symptoms of acute nasal catarrh.

Symptoms.—The general malaise, accompanied by nasal obstruction, fits of sneezing, watery discharge from the nose, which later on becomes muco-purulent or purulent, are symptoms so well known that they need no description here. Not uncommonly they are accompanied by slight deafness, tinnitus, and occasionally a little pain in the ears.

Such slight ear symptoms are probably due to catarrhal obstruction of the pharyngeal orifice of the Eustachian tube; but should the inflammation spread into the tympanum, the aural symptoms may be much more severe, and completely mask those located in the nose.

Slight Eustachian catarrh often continues for many days after the acute nasal symptoms have passed away, and repeated attacks of the latter often prove to be the primary cause of certain forms of chronic deafness.

The relationship between nasal catarrh and deafness is frequently illustrated by patients who date the onset of the ear trouble from a 'bad cold,' or who state that they are 'always much deafer when they get a cold,' each attack seeming to leave them worse than before.

Treatment.—This, to be of any service, must be undertaken directly symptoms of a threatening cold appear. The patient should keep in a room of uniform temperature, subsist on a light diet, and abstain as far as possible from fluids of all kinds until the acute symptoms tend to subside. To hasten this end, 10 grs. of Dover's powder, followed by a hot drink at night, and 5 grs. of quinine on waking in the morning, is an excellent and well-known treatment. The following is also a favourite prescription:

R	Spt. æth. nitrosi	...	...	ʒiii.
	Liq. ammon. acetat.	...	...	ʒiii.
	Liq. antimonialis	...	...	ʒii.
	Tr. opii	...	...	ʒi.
	Syrupi simp.	...	...	ʒiii.

A dessert-spoonful to be taken in a little water three or four times a day.

The inhalation of eucalyptus vapour obtained by pouring a few drops of the oil on a handkerchief will sometimes abort a cold if adopted in the early stages, and will relieve the symptom of nasal obstruction even when the attack is well developed. The same may be said of menthol vapour inhaled by means of Cushmann's inhaler, or by placing a small quantity of mentholized cotton-wool in the nostrils. Carbolyzed smelling-salts may be tried, especially in the early stages of a cold, while a nebulized solution of menthol in liquid paraffin (grs. 5 to 15 ad ʒi.) claims many advocates.

Among steam inhalations, 2 drachms of spirits of camphor in a pint of nearly boiling water will give great relief if the



FIG. 140.—NASAL DOUCHE.

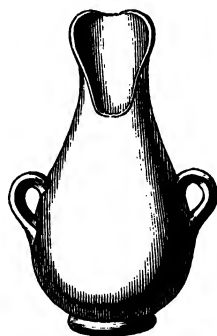


FIG. 141.—SPENCER THOMPSON'S NASO-ORAL INHALER.

vapour be inhaled through the nostrils. The solution should be placed in a narrow-necked jug, or in one of the many forms of naso-oral inhalers.

Under no circumstances should cocaine sprays be prescribed for the patient's use lest a craving for the drug be established. An exception to this rule may be made in the case of infants at the breast, where nasal obstruction precludes their obtaining their natural food. In such cases a few drops of a 5 per cent. solution of cocaine in liquid paraffin may be dropped into the nostrils a few moments before the child is put to the breast or feeding-bottle.

Although the arrest of a cold in the head is no easy

matter, a great deal may be done to render the individual less susceptible to the attacks. Amongst important prophylactic measures must be mentioned the treatment of any pathological conditions within the nose, especially the various forms of hypertrophic rhinitis and nasal obstruction.

The avoidance of over-heated rooms and of too heavy clothing when out of doors is of importance. The latter renders perspiration easy, and when bodily fatigue is added to this, a cold is easily taken.

The cold morning bath is one of the best prophylactics against taking cold. If the bath be followed by headache, prolonged chilliness, or white fingers, then the temperature of the water should be raised, especially in the case of children and old people. The bath should be followed by a brisk rubbing with a Turkish towel.

Many find a weekly Turkish bath of great service in rendering the skin less susceptible to sudden changes of temperature. Wool or silk should be worn next to the skin, and warm but light bedclothes should cover the body at night. It is scarcely necessary to point out the advantage in every way of a spring mattress over a feather-bed.

Arsenic, iron, and some form of cod-liver oil are useful aids in the treatment of anæmia, neurasthenia, and various conditions of impaired general health which render the individual peculiarly susceptible to attacks of acute rhinitis.

Chronic Hypertrophic Rhinitis.

Definition.—This form of chronic inflammation is attended by a hyperplasia of the soft tissues, and sometimes by that of the bony structure of the turbinate bodies.

Ætiology.—Repeated attacks of acute rhinitis, especially when some form of chronic nasal obstruction is present, are the chief factors in the production of the disease. Constant irritation of the nasal mucosa, either by dust, irritant vapours, purulent nasal discharges, or by frequent exposure to sudden changes of temperature, render the individual especially liable to chronic rhinitis. As predisposing causes may be mentioned those which exert their influence in acute rhinitis (*vide supra*).

Morbid Anatomy.—As a general rule, two forms of chronic hypertrophic rhinitis are met with:

(a) Those in which there is a general swelling of the tissues, and the mucosa are smooth and regular in contour.

(b) Less common forms, in which there is distension of the venous sinuses of the erectile tissue, and in which a curious swelling of the inferior turbinal mucous membrane is produced, the surface of which somewhat resembles that of a mulberry; hence the term 'moriform hypertrophy' given to this condition. The growths are often limited to the posterior extremity of the turbinal (Fig. 142), less commonly to the



FIG. 142.—VIEW OF THE POSTERIOR CHOANA AS SEEN BY POSTERIOR RHINOSCOPY.*

The left choana is normal in appearance; the lower half of the right is occupied by a moriform hypertrophy of the mucous membrane of the inferior turbinal.

anterior and posterior ends, and still less frequently the swelling forms a well-marked fringe along the whole lower border of the bone.

The mucous membrane covering the middle turbinal may also undergo hypertrophy, and a polypoid, œdematous condition of its anterior extremity is not uncommon.

In long-standing cases the bony elements of the turbinals are also enlarged and thickened.

• *Symptoms.*—Nasal obstruction and increased secretion are the two chief symptoms. The former varies from time to

* From 'Purulent Nasal Discharges' (Tilley), H. K. Lewis.

time, and is often most noticeable on lying down at night. The secretion may be profuse, clear, or at times mucopurulent, especially in the moriform type. 'Hawking' and 'sniffing' indicate the constant efforts to dislodge the mucus from the nasal and naso-pharyngeal regions.

Excessive sneezing is often a common symptom, while nasal obstruction necessitates mouth breathing, which engenders a liability to dryness of the throat and symptoms of pharyngeal and laryngeal irritation.

The voice may lose its resonance, and the sense of smell is often impaired, while varying degrees of deafness and tinnitus are not uncommon. The ear symptoms are specially

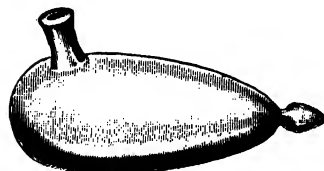


FIG. 143.—NASAL IRRIGATOR.

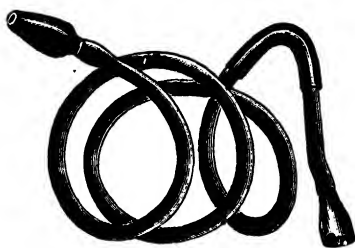


FIG. 144.—NASAL DOUCHE.

prone to occur when the posterior moriform hypertrophies encroach upon the pharyngeal orifice of the Eustachian tube.

Furthermore, frontal headache, fulness of the head, mental dulness, numbness or tight feelings over the bridge of the nose and certain ocular troubles, may result from the nasal affection, while various degrees of hypertrophic rhinitis form well-known pathological factors in the production of certain reflex troubles, such as hay-fever and asthma.

Diagnosis.—As viewed by anterior rhinoscopy, the uniform swelling of the mucous membrane of the inferior turbinal, which is slightly reducible by cocaine, renders the diagnosis easy. Spurs and deviations of the septum are hard and immobile. Polypi are semitranslucent, pendulous, and generally mobile.

In order to ascertain the presence of hypertrophies upon the posterior extremities of the turbinals, the surgeon should gently depress the tongue with a tongue-depressor,

and then pass beyond the soft palate a small laryngeal mirror or rhinoscope, upon which he should direct the light from his frontal mirror. The posterior choanæ may then be examined by turning the mirror in different direc-



FIG. 145.—THUDICHUM'S NASAL SPECULUM

tions and mentally patching together the various parts of the picture which is thus obtained.

Treatment.—In mild cases much relief may be given by the daily use of a warm alkaline nasal wash or spray :

Bicarbonate of soda	}	...	...	āā grs. x.
Borax				
Carbolic acid...	...	...	...	grs. ii.
Water	...	...	...	ʒi.

The lotion may be sniffed up from the palm of the hand, from a tumbler, or injected from one of the many apparatuses in use for the purpose. In the latter case, during the injection of the lotion, the patient must be

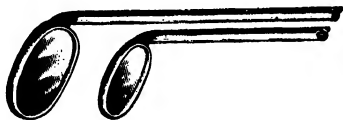


FIG. 146.—SMALL RHINOSCOPIC MIRROR. ACTUAL SIZE. (See also Fig. 35.)

instructed to hold the head over a basin and breathe quickly in and out through the widely-open mouth.

Profuse secretion may be checked by painting the mucosa (after cleansing them with the spray) with the following pigment :

R	Extr. hydrastis liq.	...	...	℥ 30
	Ac. carbol.	...	...	℥ 5
	Tr. iodi	...	...	℥ 30
	Glycerini	...	...	ad ʒi.

M. To apply with a cotton-wool holder, daily.

Failing such simple measures, active treatment should be undertaken at once.

If there be a general swelling of the mucous membrane covering the inferior turbinal, it should be anæsthetized by applying to it a small dossil of absorbent wool soaked in a 10 to 15 per cent. cocaine solution, and in from three to five minutes a linear scar should be made over the most prominent part of the swelling by means of the galvano-cautery

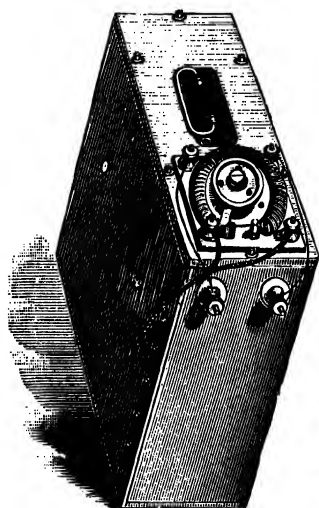


FIG. 147.—PORTABLE ACCUMULATOR BATTERY FOR CAUTERY (CONEXTER).

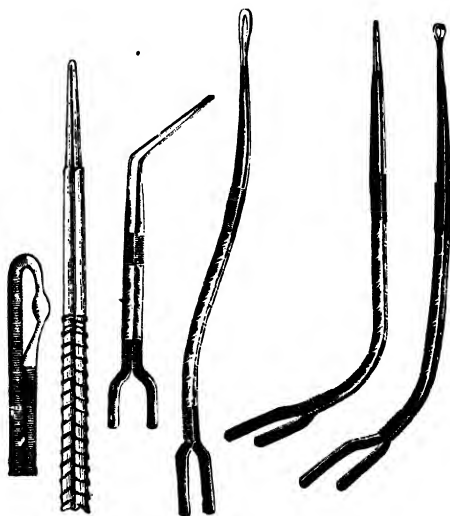


FIG. 148.—PLATINUM POINTS FOR NOSE.
(See also Fig. 75.)

point. It is better to incise the membrane with the edge, rather than to sear it down with the flat surface of the cautery terminal.

Finally, some glycerine of carbolic acid (B.P.) should be rubbed into the eschar in order to render it aseptic, and a small plug of wool, frequently renewed, kept in the nostril for twenty-four hours.

Some advise plunging the fine cautery point somewhat deeply into the swollen tissue. Internal cicatrization takes place, resulting in a contraction of the overlying mucous membrane, and consequently the nasal obstruction is removed.

If the hypertrophy be excessive, and especially if moriform growths be present, these should be removed by means of the cold-wire snare. Blake's polypus snare is especially useful for this purpose.

Should the surgeon be without a galvano-cautery apparatus, a crystal of chromic acid may be fused on to the end of a nasal probe, and then applied to the anæsthetized mucous



FIG. 149.—BLAKE'S POLYPUS SNARE.

membrane. A local slough will be produced, which usually separates after an interval of seven or eight days.

If bony as well as mucous membrane hypertrophy of the anterior end of the inferior turbinal be present, this portion should be anæsthetized, and then by means of a pair of

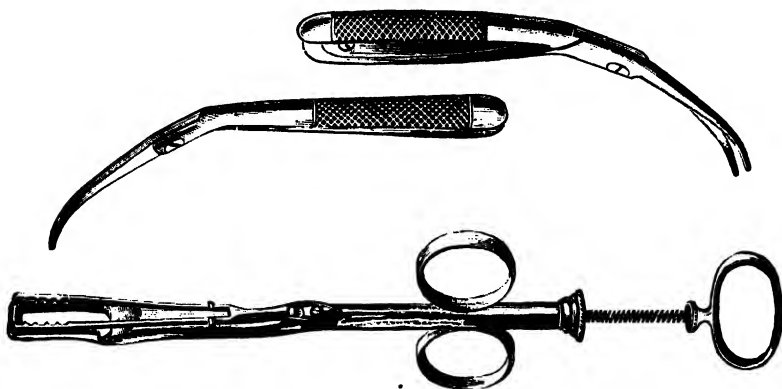


FIG. 150.—MACNAUGHTON-JONES'S SHEARS (RIGHT AND LEFT) AND TURBINATOME.

strong curved nasal scissors the anterior half of the bone should be cut through at its attachment to the outer wall of the nose, and the semidetached portion removed by the snare (Blake's). The operation gives excellent results.

Complete turbinectomy is very rarely necessary, and is an

operation not to be lightly undertaken, for not only may it be followed by dangerous secondary hæmorrhage, but the removal of so much normal mucous membrane may be followed by a distressing form of dry pharyngitis.

Atrophic or Fœtid Rhinitis (Ozæna).

This disease is characterized by a gradual atrophy of the mucous membrane and bony structures within the nose, accompanied by a purulent secretion which dries into crusts or scabs of a peculiar and characteristically fœtid odour.

Ætiology.—The essential features of the disease may be met with as early as the fourth or fifth year of infant life, but may commence even earlier than this as a purulent nasal discharge. At puberty the disease often makes rapid progress, while between thirty and forty years of age the characteristic fœtor may disappear and most of the symptoms subside.

It is more common in females, and the general health is rarely good, but this may be the result rather than the cause of the disease. Not uncommonly more than one member of the family is found to be affected. There is no evidence to show that syphilis is a causative factor in atrophic rhinitis.

Pathology.—The true pathology of the disease is unknown, and space will not allow of our discussing the various theories which have been advanced. We know that the normal ciliated epithelium is replaced by squamous cells, that the glands and venous sinuses become degenerated, and that the bone atrophies but shows no sign of actual disease. The affection may spread to the ear, naso-pharynx, pharynx, larynx, and trachea, and in the latter situations the brunt of the disease would seem to fall on the glandular constituents of the mucosa, so that these are eventually left in a thin, dry, and glazed condition.

Symptoms.—The main symptom is the discharge of foul-smelling crusts and secretion from the nose. The horrible odour which is fortunately unnoticed by the patient but is very obvious to bystanders is quite characteristic of the disease. When the larynx and trachea are involved, the patient's breath may smell quite independently of the nasal

trouble, and such an extension of the disease accounts not only for a constant cough, but also for the continual 'hawking' in the efforts to bring away the dried secretion.

Deafness, tinnitus, earache, and chronic otorrhœa may result from the spread of the disease into the tympanum by way of the Eustachian tube, and the pus from the external auditory meatus has sometimes an odour identical with that in the nose.

Indigestion and various forms of gastritis, with general mental depression, are the natural consequences of the constant swallowing and absorption of septic matter from the nasal cavities.

Examination by anterior rhinoscopy will reveal dry greenish crusts lying in abnormally patent nasal cavities, in which the bony structures are often much atrophied or have even quite disappeared.

The disease is usually bilateral, but may be much more advanced on one side than on the other.

Diagnosis.—The foregoing appearances, coupled with the characteristic smell, generally render the diagnosis easy.

The pus from suppurating accessory nasal cavities—*e.g.*, antrum, frontal sinus, ethmoidal cells—is generally liquid, yellow, and does not tend to form scabs. The fœtor in the latter case is obvious to the patient but not to bystanders. In syphilis there is usually deep ulceration tending to necrosis of bone, which is generally limited to the septum.

Prognosis.—The disease is probably never cured, but careful treatment will rob it of its worst features.

Treatment.—The great essential in the local treatment is thorough and painstaking cleansing of the nasal cavities. The nasal douche is the only satisfactory means of accomplishing the desired end—*viz.*, the removal of crusts and discharge.

In douching or syringing the nostrils, the patient should be instructed to keep the mouth widely open and to breathe quickly 'in and out' while the fluid is injected into the nose.

The solution will then pass up one nostril and out from the other, and if care be taken there will be very little risk of setting up acute otitis by forcing fluid into the Eustachian tube.

The rubber bottle may be used, or a Higginson's syringe, especially if the nasal end be fitted with a multi-perforated teat, forms an excellent means of cleansing the nasal cavities. The lotion should always be used lukewarm,

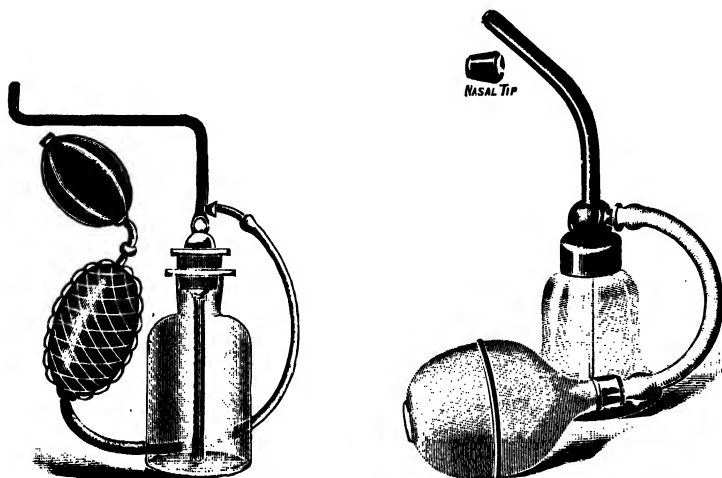


FIG. 151.—POST-NASAL AND NASAL ATOMIZERS.*

and at least three-quarters of a pint should be injected morning and evening. The disease being very chronic, the surgeon will often have to prescribe as economical a lotion as possible. Common salt $\mathfrak{z}\text{ii.}$, or chlorate of potash $\mathfrak{z}\text{i.}$, in three-quarters of a pint of tepid water, form simple and

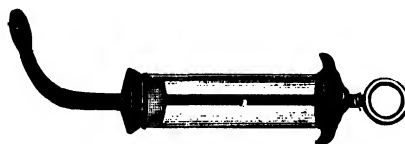


FIG. 152.—NASAL SYRINGE.

efficient washes. Another favourite cleansing lotion is composed as follows :

℞ Potass. chlor., sod. bicarb., sod. bibor. ... āā. $\mathfrak{z}\text{ss.}$
 Sacch. alb. ... $\mathfrak{z}\text{i.}$

One teaspoonful to be dissolved in a tumblerful of tepid water.

* See formulæ.

A compressed tablet composed of sod. bicarb. gr. 12, ac. carbol. gr. 1½, sod. chlorid. gr. 2, dissolved in three-quarters of a tumblerful of tepid water, makes an excellent douche, and is convenient on account of its portability.

Perchloride of mercury 1 in 5,000 to 8,000, formalin 1 in 2,000, aceto-tartrate of aluminium, 1 drachm of a 50 per cent. solution in a pint of tepid water, have all been credited with good results.

Having cleansed the nasal cavities, the patient should spray into the nostrils a nebulized solution of one of the essential oils from a nasal atomizer—*e.g.* :

℞ Oil of eucalyptus	...	℥ v.
Menthol	...	grs. x.
Liquid paraffin	...	ad ʒi.

The mucous surfaces are thus covered by an oily coating



FIG. 153.—OIL ATOMIZERS.*

which retards scab formation and overcomes the fœtor of the disease.

If such measures be not followed by rapid improvement, the surgeon may paint the mucosa twice weekly with the following pigment :

℞ Iodi, ac. carbol., potass. iodid.	...	āā grs. iv.
Glycerini	...	ʒss.
Aqua distill.	...	ad ʒi.

* See formulæ.

In order to induce free secretion within the nose and a loosening of the scabs, the nasal cavities may occasionally be lightly packed with mentholized cotton-wool. The plugs should be removed in four or five hours' time, and the nasal cavities well douched.

Cupric electrolysis applied to the nasal mucous membranes has been credited with good results by some rhinologists. A copper needle is attached to the positive and a platinum needle to the negative pole of the battery. The former is passed into the middle or inferior turbinal, the latter into the septum. A current of 3 to 10 milliampères is allowed to pass for about ten minutes. The operation may be repeated at intervals of ten days to a fortnight.

The general health of the patient should always be attended to, iron, arsenic, and cod-liver oil being especially suitable in these cases.

When possible, a few weeks' residence on the muddy shores of the Bristol Channel seems to produce a special beneficial action in cases of atrophic rhinitis.

Nasal Polypi.

Definition.—Tumours of a soft, jelly-like nature growing within the nasal cavities.

Pathology.—They are the result of chronic inflammatory changes in the mucous membrane of the ethmoidal region, due to an underlying inflammation of the ethmoid bone.

Springing from the middle meatal region of the nose, polypi are smooth, globular, semitranslucent, generally multiple, frequently bilateral, and, if of long standing, they tend to become pedunculated. They vary in size from a pea to a mass which may completely fill the nasal cavity and by its pressure produce marked expansion of the bony skeleton of the nose. Chronic empyemata of any of the nasal accessory cavities which discharge the pus into the nose are very frequently accompanied by nasal polypi.

Symptoms.—Nasal obstruction, excessive watery secretion from the nose, loss of smell, and impairment of vocal resonance, are the commonest symptoms.

In other cases fits of sneezing, catarrhal deafness, and tinnitus, possibly associated with a sense of dulness and mental apathy, are additional symptoms. Certain reflex effects—*e.g.*, cough, hay-fever, asthma, and even epilepsy—have been cured by removal of nasal polypi.

Diagnosis.—By anterior rhinoscopy the glistening, semi-translucent growths may usually be seen without difficulty; they are painless when touched by a probe, and practically always spring from the middle meatal (ethmoidal) region. In some cases, and these are more likely to effect the hearing, it may be impossible to see the polypus except by means of posterior rhinoscopy.

Prognosis.—If *thoroughly* removed, the result of treatment is very good; inefficient removal generally means recurrence.

Treatment.—The nostril should be dilated with a speculum (Fig. 145), the nasal cavity well illuminated by indirect light from a frontal mirror, and the growths anæsthetized by applying to their bases a 10 to 15 per cent. solution of cocaine

on a cotton-wool swab. In from five to ten minutes the polypus may be removed by means of a cold-wire snare. Blake's instrument (Fig. 149, *vide* p. 263), loaded with No. 5 piano wire, is excellent for this purpose, and the writer has never found it fail. Another favourite instrument is Hovell's modification of Mackenzie's snare (Fig. 154). The growths should be seized as near to their base as possible; in fact, the surgeon should always endeavour to remove the bony structures in the immediate neighbourhood of the base of the polypus. In the case of many small polypi which may be

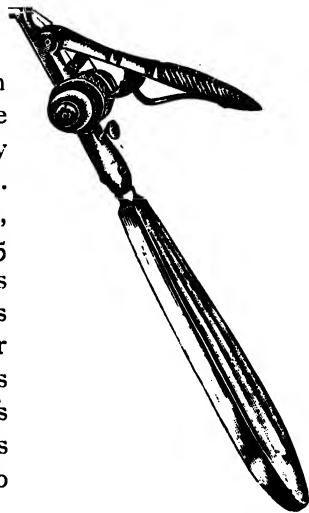


FIG. 154.—HOVELL'S MODIFICATION OF MACKENZIE'S SNARE.

unsuitable for a snare, Grünwald's forceps (Fig. 156) may be used to advantage for their removal. Should the growths rapidly recur, indicating more deeply-seated bone mischief, the patient should be anesthetized and the ethmoidal region thoroughly but very carefully curetted until the diseased bone is removed. In view of the close proximity of the cribriform plate and of the orbit, such a proceeding should only be undertaken by those accustomed to all the

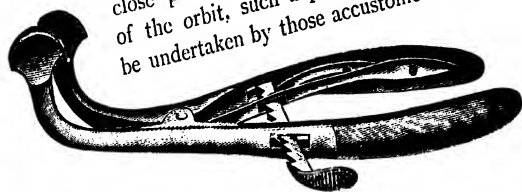


FIG. 155.—MOUTH GAG.

details and technique of intranasal surgery. In skilled hands the operation has given excellent results.

Should the polypi accompany suppuration in any of the nasal accessory cavities, it will be necessary to treat the latter condition before hoping for a cure of the intranasal growths.

The insufflation of desiccating powders,

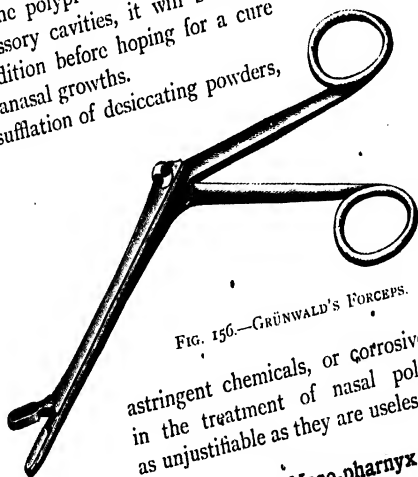


FIG. 156.—GRÜNWARD'S FORCEPS.

astringent chemicals, or corrosive acids in the treatment of nasal polypi are as unjustifiable as they are useless.

Adenoid Growths in the Naso-pharynx.

Definition.—A morbid hypertrophy of the adenoid tissue which normally exists in the naso-pharynx of young children.

Ætiology.—Of the causative factors of this affection we have no certain knowledge. Adenoid growths are more common in temperate climates than in tropical regions; they often affect several children in the same family, and this irrespective of social position. They rarely produce symptoms during the first year of life, but from the third to the tenth year they most commonly attract attention; not infrequently the onset of symptoms dates from an attack of one of the acute infectious disorders. At puberty adenoid growths, which have not hitherto sufficiently developed to cause symptoms, may spontaneously disappear, while in other cases the growth continues to develop, and may necessitate removal up to thirty years of age, or even later.

Morbid Anatomy.—As already stated, adenoid growths may be regarded as a morbid hypertrophy of the pharyngeal (Luschka's) tonsil. The increase may be so slight that no symptoms of the growth are produced; in other cases the hypertrophy may extend to the vault and sides of the naso-pharynx, so that the posterior choanæ are completely occluded, Rosenmüller's fossæ filled, and the pharyngeal orifice of the Eustachian tube obstructed by the exuberant lymphoid overgrowth.

The latter structure is very similar to that of the faucial tonsils, and superficially the growth is covered by a columnar ciliated epithelium.

Enlarged faucial tonsils are often associated with the post-nasal growth.

It is important to bear in mind that adenoid vegetations may form the primary seat for the development of tubercle bacilli, and that the researches of Sims Woodhead and others would seem to demonstrate that many cases of tubercular cervical glands are secondarily infected from a primary tubercular deposit in the gland-tissue of the naso-pharynx or in the faucial tonsils.

Symptoms.—Perhaps the commonest symptoms noticed by the parents of a child suffering from adenoids are snoring or difficulty of breathing during sleep, recurrent attacks of deafness or chronic ear discharge, a tendency to

breathe through the mouth during the day, and very frequently there is a bilateral muco-purulent nasal discharge.

Under no other conditions are the effects of nasal obstruction upon the general system so well illustrated as in the affection under discussion.

The open mouth, with the upper lip projecting away from the teeth, the pinched and narrow nostrils, raised eyebrows, and indrawn inner angles of the eyes (Fig. 157), give to the patient a stupid, semi-idiotic appearance, which to a practised eye is almost pathognomonic of adenoids. A closer



FIG. 157.—APPEARANCE OF PATIENT SUFFERING FROM ADENOID GROWTHS IN THE NASO-PHARYNX.

From a photograph (Cresswell Baber).

examination will show a tendency to a high, narrow-arched palate, with undue crowding and misplacement of the incisor teeth, while the nasal cavities and surrounding facial bones are imperfectly developed, giving rise to the long, narrow face so characteristic of the disease. This lack of facial development is almost entirely due to the nose having relegated its respiratory functions to the mouth.

As a result of the constant attempt to breathe through the nostrils, which are in-

completely obstructed, a characteristic deformity of the chest is often produced, consisting in a circular depression of its walls at the junction of the lower and middle third, with an appearance of abnormal bulging at the upper part of the thorax.

The evils of mouth breathing induced by the post-nasal obstruction include pharyngeal, laryngeal, and bronchial catarrh, as well as those minor degrees of irritability which may only be productive of a hacking cough. Snoring or difficulty of breathing during sleep, and noisy breathing

(especially when eating) during the day, are well known symptoms of adenoids.

As a direct consequence of the nasal obstruction, there is a 'deadness' or absence of resonance in the vocal sounds, and the consonants *m* and *n* are converted into *b* and *d* respectively.

A bilateral muco-purulent nasal discharge in a young child is very characteristic of adenoids. Scarcely less common than the foregoing symptoms are those referable to the ear. Temporary and recurrent attacks of deafness due to simple Eustachian catarrh are very common, and they may be associated with various degrees of earache which may often be immediately relieved by inflation of the tympana. In other cases acute and chronic suppurative inflammation of the tympanum results, and it is probably within the mark to say that 90 per cent. of the chronic ear discharges of young children are primarily due to adenoid vegetations of the naso-pharynx. If we bear in mind the complications which are liable to supervene in a case of neglected chronic suppurative otorrhœa, the need of attention to their primary factor will be at once evident.

Many children the subject of adenoids suffer from distressing nightmare, night terrors, etc., which often cease on removal of the growth, possibly because of the better oxygenation of the blood thus induced.

In rarer cases hæmorrhage may occur from the lymphoid overgrowth, and on the child coughing up the blood, hæmoptysis from lung disease is closely simulated, and the general ill-health of the patient, associated possibly with some bronchial catarrh, will lend further weight to the suspicion of pulmonary mischief.

The mental condition of adenoid patients is often characteristic. They may be dull and apathetic, backward in their lessons, and quite disinterested in the games of the playground. Whether such a condition be due to deficient oxygenation of the blood or obstruction of the lymphatic circulation of the brain is undecided.

In yet other cases various reflex symptoms have been reported as having immediately disappeared after the removal

of these growths—*e.g.*, nocturnal micturition, ocular defects, asthma, convulsions, etc.

Diagnosis.—The symptoms and appearances already noted rarely leave one in much doubt as to the diagnosis. In order to make certain of the presence of the growths, the post-nasal space may be examined by reflected light with a small laryngeal mirror; where this method is possible the patient will be saved the discomfort of a digital examination. Should it be impossible, the surgeon should pass his index-finger into the naso-pharynx; if adenoids be present they will easily be felt as a soft, non-resisting mass, and the finger, on withdrawal will often be tinged with blood. A piece of rubber tubing surrounding the proximal phalanx of the index-finger will prevent the surgeon from being bitten by the patient.

Prognosis.—Bearing in mind the far-reaching evil effects of well-developed adenoids, and, on the other hand, the brilliant results which almost always follow efficient removal of the same, we need have little hesitation in urging patients to submit to the necessary operation. There is very little risk of recurrence if the growths be efficiently removed. Their presence probably renders a patient more susceptible to the acute specific disorders, while the liability of the gland-tissue to form the primary seat of tubercle, followed by secondary infection of the cervical glands, has already been pointed out.

On the other hand, a small adenoid hypertrophy, occurring in a healthy child and giving rise to no symptoms, does not call for urgent removal.

Treatment.—In accordance with the last paragraph, it may again be said that the removal of adenoid growths should only be undertaken when their presence is betrayed by certain definite symptoms already enumerated.

As a rule, children stand the operation very well, and from three to six years of age is perhaps the best time for operating, because the chest and facial deformities have not yet become permanent or irremediable. After puberty the shock of the operation is more pronounced and the growth is more difficult to remove on account of its toughness. With due care

to exclude cold and draughts, adenoids may be removed at any time of the year.

Unless for urgent reasons the operation should not be performed during the raging of an epidemic of any of the acute specifics or of influenza, because the raw surface left by the operation is very liable to infection. For a similar reason their removal should not be undertaken in insanitary surroundings.

The position of the patient, method of operating, and the choice of anæsthetics vary with different surgeons. Nearly all are agreed that general anæsthesia is as wise as it is humane.

With regard to the choice of an anæsthetic, it is the practice of the writer to be guided by the age and temperament of the patient, and also by the co-existence of enlarged tonsils which should be removed at the same time as the adenoids. If the child be not unduly nervous and adenoids only exist, nitrous oxide anæsthesia will give ample time, in skilled hands, for removal of the growth by one of the modifications of Gottstein's knife, followed by a final search with the index-finger. If the patient be very young (under four years) and nervous, chloroform will be the best anæsthetic.

If tonsils and adenoids be present, gas, or gas and oxygen, will often suffice, if both the anæsthetist and operator be experts in their work. Under other circumstances chloroform, gas and ether, or the A.C.E. mixture, will be most suitable, and one of these will be imperatively necessary if the surgeon uses forceps for the removal of the growth, because under such circumstances some five to ten minutes' anæsthesia may be required.*

The only disadvantage of gas and ether in the removal of adenoids is the increase of hæmorrhage as compared with chloroform. The following method of operating is that which is always followed by the writer :

The patient having been anæsthetized and lying on his back, directly the operation is to be performed the head is allowed to hang backwards over the edge of the table, so that no

* See chapter on 'Anæsthesia' in 'Nasal and Aural Surgery' by Dr. Dudley Buxton.

blood or growth may escape into the larynx. A Gottstein's ring knife (Fig. 158) or one of its modifications is passed above and behind the palate until the roof of the naso-pharynx is reached, and then, by a combined movement of backward pressure and downward withdrawal of the instrument, the growth is generally removed *in toto*. Any little adenoid tissue remaining in Rosenmüller's fossæ or at the upper edge of the choanæ may be easily scraped away with the index-finger.

Some surgeons prefer the head slightly raised on a pillow, and trust to careful and rapid sponging to prevent the flow of blood into the larynx. Others, again, operate with the patient lying on one side.

If forceps (Fig. 160) be used, they should be carefully



FIG. 158.—GOTTSTEIN'S RING KNIFE.



FIG. 159.—DELSTANCIE'S MODIFICATION OF ABOVE.

guided into the naso-pharynx, care being taken not to injure the uvula. The growth is torn away piecemeal, and any remaining bits must be cleared away by the finger. The removal by forceps takes a much longer time, and has no advantage over the shorter and very efficient method carried out by one of the modifications of Gottstein's curette.

Tonsils accompanying adenoid growths should be removed at the commencement of the operation (*vide infra*).

The hæmorrhage which follows the removal of the growths, though free for a few moments, soon ceases, and there is rarely any need for applying sponges to the post-nasal space. Very occasionally there may be some free bleeding, and fatal cases of primary and secondary hæmorrhage are on record.

Hæmorrhage occurring within a few hours of removal is

often due to a semi-detached portion of adenoid growth which has been left behind, or to undue exertion on the part of the patient. In the first case the loose piece of growth should be removed, while in the second some cold water to which some hazeline may be added should be injected into the nostrils; at the same time the patient should keep absolutely at rest, pieces of ice may be sucked, and small doses of opium may be prescribed.

Under ordinary circumstances milk and soda-water, cold jellies and cold milk-puddings, may be taken from four to six hours after the operation, semi-solid food the following day, and normal diet on the third day after the operation.

If the child vomit, the return of the blood swallowed immediately after the operation may alarm the parents, who will think hæmorrhage is continuing unless they be warned

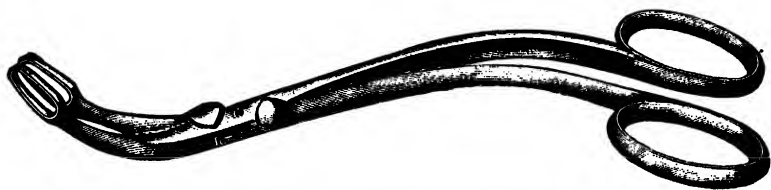


FIG. 160.—JURACZ'S POST-NASAL ADENOID FORCEPS.

beforehand that such an occurrence is no cause for anxiety. Earache and deafness sometimes supervene some twelve hours after the operation, and often may be at once relieved by inflation of the tympanum by Politzer's method.

Follicular tonsillitis, acute otitis media, or marked pyrexia, should never follow the operation if it be performed with ordinary surgical cleanliness and due precautions to exclude insanitary influences be taken.

Removal of adenoids by means of the natural or artificial (Dalby's) finger-nail cannot be recommended. Good results may be obtained in a few hands, but as a general rule the writer has found that most cases of recurrence have been treated by this means, and it is more probable that inefficient removal is the true explanation of many of the so-called 'recurrences.'

Insufflation of powders, astringent paints, etc., can only

be described as irritating and useless as far as any permanent result is concerned.

From the day following the operation the patient should be encouraged to breathe through the nose with the mouth closed, and a few minutes spent two or three times a day in simple gymnastics under such conditions will soon make the natural method of respiration a matter of ease and comfort.

In conclusion, it need scarcely be said that the general health should be cared for after the operation, and to this end such preparations as the iodide of iron, cod-liver oil, maltine, or the hypophosphites, should be given in conjunction with a liberal diet and plenty of exercise in the open air.

Deviations, Spurs, and Crests of the Nasal Septum.

It has already been pointed out (p. 252) that there is often some relationship between nasal stenosis and aural affections and that, speaking generally, it is the moist forms of aural catarrh which are most likely to be benefited by intranasal treatment, while the latter is little likely to be of use in cases of so-called 'dry or sclerotic catarrh of the middle ear.'*

The most common forms of nasal obstruction due to septal irregularities are :

1. Anterior dislocation of the cartilaginous septum.
2. Simple deviation of the septum, mainly cartilaginous.
3. Irregular deviation in the vertical or antero-posterior direction, with or without spurs.
4. 'Spurs' or 'crests,' with or without deviation of the septum.

By 'deviation of the septum' is meant an inclination of the septum to one side or the other, producing an increased space in one nasal cavity at the expense of the other. A 'spur' signifies a localized rounded or pointed outgrowth; it may be cartilaginous or bony, or consist of a mixture of both elements. The term 'crest' is used to signify an irregularity extending along a considerable portion of the septum, and generally producing a ridge more or less parallel to the opposite inferior turbinal.

* See also chapter on Some Causes of Deafness.

The following diagrams indicate various forms of intranasal irregularities which are commonly met with :

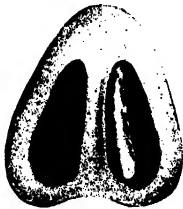


FIG. 161.—ANTERIOR DISLOCATION OF SEPTUM.



FIG. 162.—DEVIATION OF SEPTUM.



FIG. 163. SEPTAL SPUR.



FIG. 164.—DEVIATED SEPTUM AND SPUR.

Ætiology.—Traumatism is probably the most potent factor, although it may often pass unnoticed, especially in children. Rickets, irregular development of the facial bones about the seventh year, and unequal development of the two bony plates forming the vomer after puberty, have also been looked upon as ætiological factors.

Symptoms.—In a young child nasal stenosis is most often due to adenoids, and a detailed account of the symptoms of stenosis thus produced will be found when dealing with that affection. Obstruction due to septal irregularities rarely comes before the notice of the surgeon until the age of puberty or thereabouts, often much later. Complaint may be made of inability to breathe through the mouth, especially at night, so that on waking in the morning the tongue is furred, the throat may be dry and irritable, and the back of the nose filled by secretions which have accumulated during the night and which may be difficult to dislodge on waking. Such conditions predispose to attacks of acute

nasal catarrh and hypertrophic rhinitis, during which deafness or temporary tinnitus may be present. The sense of smell is often absent or deficient on the obstructed side. Such irregularities may also form the starting-point of such reflexes as cough, asthma, headache, etc.

Prognosis.—The removal of well-marked nasal obstruction of any kind is often fraught with great relief to the patient, and may be followed by the total disappearance of many of the local and reflex symptoms already referred to.

The various forms of ear trouble which may be thus relieved or cured have already been discussed.

Indications for Operation.—In these days of surgical enthusiasm it may be well to warn the practitioner of the exaggerated importance which has been ascribed to certain deformities of the nasal septum, and to insist that a small septal spur should not be interfered with unless surgical interference is called for upon one or other of the following grounds:

(a) Marked nasal obstruction.

(b) Reflex symptoms which seem to bear a definite relation to the nasal obstruction.

(c) Moist forms of aural catarrh associated with deafness or tinnitus, and in which there is reason for believing that the nasal catarrh is aggravated by the presence of the obstruction. Under such circumstances relief of the aural symptoms may often be obtained by providing free nasal respiration.

(d) Where the obstruction renders removal of polypi, the passage of an Eustachian catheter, or other intranasal operations a matter of difficulty.

Treatment.—Anterior dislocations of the septum may be best relieved by raising a flap of mucous membrane, dissecting out the underlying cartilage, and replacing the mucous covering, which may be held in position by a fine stitch. General anæsthesia will nearly always be necessary.

Spurs.—If a septal spur or crest be purely cartilaginous, and the patient be tolerant of a moment's pain or discomfort, the obstruction should be anæsthetized with a 15 per cent. solution of cocaine applied on cotton-wool, and the spur may

then be removed by means of a sharp scalpel. Hæmorrhage soon ceases, and intranasal plugging is rarely necessary.

Should the crest be long and bony, it is better to administer a general anæsthetic. If the operator be dexterous, 'nitrous oxide gas' may give a sufficiently long anæsthesia. By means of a nasal saw a groove is rapidly made into the upper surface of the crest, and then the blade of a turbinate is passed behind the obstruction, firmly fixed into the saw groove and rapidly withdrawn. A smooth surface level with the septum is left, which rapidly heals.

In all these operations hæmorrhage will be much reduced if a 10 per cent. solution of suprarenal extract be applied to the parts some ten or fifteen minutes before operating.

Deviations.—The only satisfactory method of dealing with intranasal deviations of the septum is by operation under a general anæsthetic. Plugs, bougies, and all similar contriv-



FIG. 165.—ADAMS' SEPTUM FORCEPS.

ances are useless annoyances, and productive of no permanent good.

First Method.—After removing any irregularities, the septum should be forcibly rectified by means of forceps—*e.g.*, Adams' (Fig. 165)—after which, and in order to keep the septum in its new position, it will be necessary to wear some form of splint or plug. Lake's rubber nasal splint, or a piece of firm, thick-walled, rubber drainage-tube, with one or two lateral openings, make very efficient plugs.

Second Method (Asch's).—By means of special instruments crucial incisions are made over the most prominent portion of the septum, and the resulting segments are forced by the finger into the concave side until, by the fracture of their bases, the resiliency of the septum has been destroyed. A perforated plug is worn in the obstructed side for some four or five weeks, being removed every twenty-four or forty-eight hours for purposes of cleansing.

Naso-pharyngeal Catarrh.

This affection may occur in the acute or chronic form, and the latter cases may be divided into *moist* and *dry* catarrh.

Acute Naso-pharyngitis is often met with in connection with acute rhinitis, and is due to the same causes. The swollen and congested mucosa give rise to a free discharge of mucous secretion, and there may be some discomfort at the back of the nose, with slight pain on swallowing. These symptoms are often associated with those characteristic of acute rhinitis (*vide supra*), and the general discomfort is not rarely enhanced by deafness, tinnitus, and earache.

Treatment.—The general treatment laid down for acute rhinitis should be followed. Locally a warm alkaline nasal douche—*e.g.*, equal parts of borax, salt, and bicarbonate of soda, ʒi. to a pint—used two or three times daily will remove the secretion and give considerable relief.

Chronic Naso-pharyngitis.—*Ætiology*.—Both the moist and dry form of the disease are commonly associated with some form of chronic rhinitis, and, generally speaking, arise from similar causes. In young adults the fibrous remains of old adenoids are a frequent cause of the moist catarrh, while excesses in eating, alcohol, and tobacco, especially in gouty, plethoric individuals, are well-known factors of the affection in adult life.

Moist Catarrh.—In this form the troublesome symptom is an excessive muco-purulent secretion in the back of the nose, which by constantly passing into the patient's throat, engenders a habit of sniffing or hawking in the effort to dislodge it. The accumulation of the secretion during sleep may cause violent retching and even vomiting in the morning. Deafness and tinnitus of varying intensity may result from extension of the catarrh to the Eustachian tubes, while pharyngeal and laryngeal symptoms denote a spreading downwards of the affection. The secretion in the naso-pharynx is of varying consistency, and if it be muco-purulent it may suggest chronic suppuration of the ethmoidal, sphenoidal, or other nasal accessory cavities.

When the disease is limited to the pharyngeal tonsil, it is

sometimes spoken of as Tornwaldt's disease, and, should the opening of the bursa become occluded, a chronic abscess or cyst may result.

The affection is often aggravated in cold, damp weather, and may disappear spontaneously under the influence of warm and dry atmospheres.

Dry Catarrh.—In this form examination of the pharynx and naso-pharynx show the mucosa to be dry, shining, and often covered with a thin veneer of yellowish-brown, viscid mucus, and in some cases actual crusts of dry secretion. Rosenmüller's fossæ appear to be deepened, and the Eustachian orifices stand out sharply. If the discharge be removed, the underlying mucous membrane is generally red, showing the veins and capillaries in a gorged condition.

Treatment.—In both forms of disease such general ætiological factors as gout and rheumatism must be cared for. It may be necessary for the patient to abstain from alcohol and tobacco (especially inhaling), and the amount and nature of the food taken may require regulation; spiced and highly-seasoned articles of diet being especially contra-indicated.

Hypertrophic rhinitis, well-marked septal obstructions, and adenoid vegetations will generally require active surgical treatment.

A warm alkaline nasal douche (p. 261), used twice daily, will generally give great relief in both the moist and dry catarrh, and in mild cases will be all the treatment that is necessary.

In more chronic cases of moist catarrh, rapid improvement will often follow if the naso-pharynx be painted twice or three times weekly with nitrate of silver, grs. x. ad ʒi., zinc chloride, grs. xxx. ad ʒi., or with the following pigment:

R	Iodi)	•	
	Potass. iodid.	)	...	...
	Ol. menth. piper.		....	... ℥iii.
	Glycerini	...	...	... ʒi.
			Mix.	

These pigments should be applied to the post-nasal space by means of a suitably curved naso-pharyngeal brush or wool-covered probe.

Inhaling the fumes from cigarettes of eucalyptus or cubebs will be found useful in both the moist and dry forms of the disease.

In dry naso-pharyngeal catarrh, after removal of the inspissated secretion by means of a douche, the parts should be swabbed with the pigments already mentioned, or with lactic acid in 40 to 70 per cent. solutions. The accompanying pharyngitis should be treated at the same time. Here the effervescing chlorate of potash lozenges, the compound eucalyptus, and the compound menthol pastilles, often give great relief.

In anæmic individuals iron and arsenic, or the syrup of iodide of iron will be indicated; in young adults cod-liver oil and iron, the hypophosphites and lime preparations, will be found especially useful.

Suppuration or cyst formation in connection with the pharyngeal tonsil will necessitate surgical treatment. Under these circumstances, the tonsil should be removed by means of Gottstein's curette or by adenoid forceps (*vide infra*).

Hypertrophy of the Tonsils.

This is mainly a disease of early life and the enlargement may date from infancy, or develop during childhood or at puberty. Sometimes they appear to be congenital, at other times the rapid growth dates from an attack of measles, scarlet fever, or diphtheria.

As a general rule, enlarged tonsils tend to disappear as adult life is approached, but there may be many exceptions to this rule.

Morbid Anatomy.—Three chief varieties of enlarged tonsils are met with:

1. *Lymphoid Variety.*—Those in which the tonsils are large and soft—*e.g.*, those in which the adenoid tissue is well developed.

2. *Fibrous Variety.*—Tonsils which are large and tough, owing to the excessive development of the fibrous tissue elements.

3. *Lacunar Variety.*—Those in which the tonsillar crypts

are filled with a yellowish, foul-smelling secretion, consisting of pus cells, epithelial debris, and a variety of septic organisms.

Hypertrophied tonsils vary much in size and shape. They may project towards the middle line, being only attached by a thick pedicle, or the hypertrophied gland-tissue may form a flattened mass extending down to the sides of the tongue and forming a thickening of, rather than a projection from, the sides of the throat.

Adenoids are often associated with hypertrophied tonsils and both of these affections with enlarged cervical glands.

Symptoms.—The obstruction to breathing often causes many of those symptoms which have already been enumerated when dealing with adenoids—*e.g.*, mouth breathing, difficulty of breathing, snoring, tendency to pigeon-breast, narrowing of the face, and general listlessness and dulness. The voice is characteristically throaty and guttural, and the senses of smell and taste may be impaired.

Deafness is a common symptom induced by enlarged tonsils, and may be due either to direct pressure of the tonsils on the Eustachian tubes, or to catarrh spreading into the latter from the naso-pharynx.

Diagnosis.—There can be no difficulty in recognising enlarged tonsils when they exist, although it is somewhat surprising how often children are sent to hospitals to have their tonsils removed, when, practically speaking, such a condition does not exist.

Prognosis.—Few surgical operations are followed by such immediate and permanently good results as removal of enlarged tonsils. The effect on the voice is generally to improve it, and to render the throat altogether stronger. The fear occasionally expressed even to-day, that excision of the tonsils may interfere with the sexual development, is absolutely groundless. On the other hand, if a child suffering from enlarged tonsils be attacked by scarlet fever, diphtheria, small-pox, etc., the unhealthy condition of the throat renders the prognosis graver, and will be an additional argument in favour of removal of the obstruction before such conditions supervene.

Treatment.—When chronically enlarged tonsils give rise to symptoms, they should be removed, and time is only wasted by the local application of caustics, paints, and astringent powders. It is true that if the hypertrophied tonsil be still further enlarged owing to a slight cold, insufflations of guaiacum powder, followed by local applications of a pigment of perchloride of iron (3i. to ʒi.), may reduce it to its usual size; but such means will not cause a gradual atrophy or destruction of the tonsil substance. The same may be said of ‘London paste,’ nitrate of silver, powdered alum, etc.

Enlarged tonsils may be removed by four different methods:

First Method: Removal by the Guillotine.—The most suitable instrument for this purpose is that of Mackenzie.

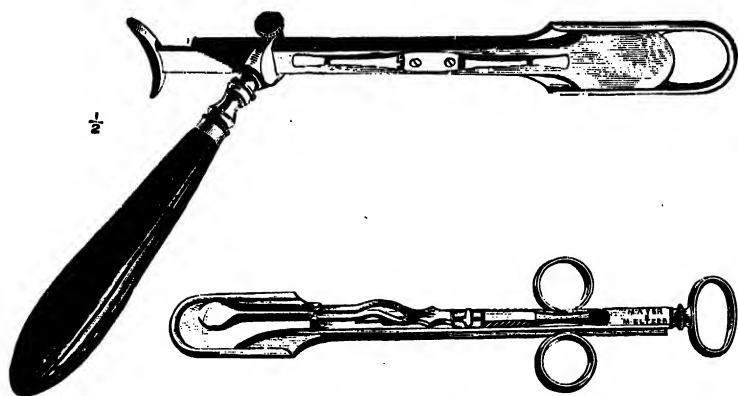


FIG. 166.—TONSIL GUILLOTINES.

The operation is best performed with the patient in a sitting position and without a general anæsthetic; but if he be nervous, ‘gas’ anæsthesia will give the surgeon ample time to remove the glands. If adenoids be present, a longer anæsthesia may be necessary (*vide* p. 275). The removal of the second tonsil should follow immediately on that of the first.

If the tonsils do not project towards the middle line, it is well that an assistant should stand behind the patient, and press upwards and inwards behind the angle of the jaw to enable the operator to engage the tonsil more easily within the ring of the instrument.

The various guillotines containing hooks to catch and draw the tonsil to the middle line are not so satisfactory as the simpler form already mentioned.

In adults, where the liability to hæmorrhage is greater than in children, some surgeons prefer to use a cold-wire snare, used in the same manner as for the removal of nasal polypi. The method is safe, but very painful for the patient.

The hæmorrhage following tonsillotomy is not, as a rule, severe. In young children it is rare, but from fourteen to twenty-one years of age it is somewhat more frequent. In adults it is an emergency which must always be prepared for.

When the hæmorrhage is slight and the oozing is general, it may be checked by sucking pellets of ice. If this be not sufficient, the surgeon should soak a small pledget of wool or soft sponge in the following mixture, and apply it to the bleeding surface :

R	Tannic acid ...	...	...	360 grs.
	Gallic acid ...	...	...	120 grs.
	Water ...	...	...	1 oz.

Counter-pressure applied externally below the angle of the jaw will materially assist in checking the hæmorrhage.

The patient should then remain quiet for six to twelve hours, and at frequent intervals during this time suck small pellets of ice.

If the hæmorrhage be very severe, it may be possible to see the bleeding-point, and to secure it with a long pair of artery forceps. The hæmorrhage will nearly always cease if the patient become faint from loss of blood, but in extreme cases the necessity of tying the external carotid artery between the superior thyroid and the lingual branches may have to be considered.

Under ordinary circumstances, after tonsillotomy the patient should take cold semi-solid food for two or three days, and then resume ordinary diet. Sedative pastilles such as the marsh-mallow lozenge or the borax and cocaine pastilles, will enhance the patient's comfort during the first few days after the operation.

Second Method.—On account of the risk of hæmorrhage, some surgeons advise the gradual removal of the tonsils in

patients over the age of puberty. There are, moreover, some patients who do not object to losing their tonsils provided they are not 'cut.' Under such circumstances the desired end may be attained by means of the galvano-cautery.

A fair-sized cautery point should be passed into the tonsil at three or four separate places at one sitting, and the operation again repeated at intervals of a week or ten days. In this way the tonsil may be gradually destroyed, but the method is tedious and painful.

Third Method: 'Morcellement.'—This method should be reserved for those cases in which there is a large, ragged, flat tonsil, which cannot be made to enter the ring of a guillotine. The instrument figured here (Fig. 167) will be

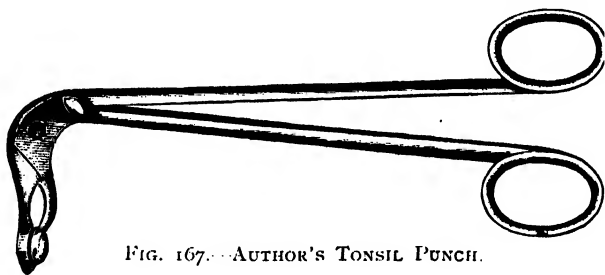


FIG. 167.—AUTHOR'S TONSIL PUNCH.

found especially useful in such cases, for by its means the tonsil substance may be rapidly 'punched' out with little pain, and the operation completed in the course of one or two sittings.

Fourth Method: Enucleation of the Tonsil.—With the instrument above described, enucleation can be rarely necessary. The operation consists in dissecting the anterior and posterior pillars off the tonsil substance, and then, by means of the finger-nail, peeling the gland out of its bed from above downwards. The method is, of course, reserved for large flat tonsils unsuitable for a guillotine, and can only be carried out under general anæsthesia.

For other nasal and naso-pharyngeal instruments not included in the text, see plate in Appendix.

CHAPTER XI

THE INTERNAL EAR

By H. MACNAUGHTON-JONES

Pathology.

IN discussing diseases of the internal ear, we will include for our purpose all the structures entering into the formation of the labyrinth and the auditory nerve. It is only of recent years that our knowledge has increased with regard to the pathological changes found in the various structures forming the internal ear. While we are indebted to many workers for the light thrown on the causation of obscure symptoms of labyrinthine disease, it is not invidious to mention the names of Politzer, Schwartze, Gruber, Steinbrugge, Gradenigo, and Habermann on the Continent, and Moos in America, as those to whom we are more particularly indebted.

Hyperæmia, if acute and intense or sustained for a lengthened period, leads to various degenerative changes, of which the following are the most important.

Hæmorrhage and Hæmorrhagic Infarctions, with Extravasation.—Bleeding into any part of the labyrinth is followed by the consequences which attend upon blood extravasation in other parts. If it be not absorbed, there are degenerative changes of a fibrous or calcareous nature. The effusion may produce degenerative epithelial atrophy, connective-tissue formations in the membranous and osseous canals, or the effusion may break down into pus formation. Should hæmorrhage not occur as the result of hyperæmia, there may ensue thickening and hypertrophy of the membranous

labyrinth, permanent enlargement of the vessels, attended with varying degrees of exudation and possibly deposition, both calcareous and pigmentary.

Exudations and Infiltrations.—As a consequence of inflammation of the labyrinth, we have various exudations and infiltrations. These may be either of the nature of a simple exudation (Gruber), serous, lymphoid and cellular, hæmorrhagic, or purulent.

Hyperplastic changes in the labyrinth have also terminations similar to those met with elsewhere, dependent upon the site of the hyperplasia and the character of the tissue in which it occurs.

Degenerations.—Thus we have osseous thickening and deposit, proliferation of connective tissue, calcareous degeneration or phosphatic deposition, periosteal and subperiosteal thickening, and in some instances amyloid changes. As a result, there are found encroachments in the canals of the labyrinth, with complete or partial blocking of these by new osseous formations in different situations, and filling the space between the osseous and membranous labyrinth (Moos). The latter is altered by these exudative processes, being thickened by epithelial proliferation and endo-arterial inflammation. In the labyrinth, also, occur those endotheliomatous degenerations in the bloodvessels which are found in other situations, and as a consequence there is blood stasis, leading to thrombosis and fatty as well as colloid degeneration of the surrounding tissues.

Micro-organisms.—Apart from these pathological states, we find the labyrinth invaded by micro-organisms, the avenues of entrance being either through the vessels and lymph-spaces, the aqueducts, or with the sheath of the auditory nerve, the products of suppuration reaching the labyrinth through these same channels. Thus in the labyrinth we have a process of mycosis analogous to the condition found in the middle ear, and the same septic organisms—the streptococcus and staphylococcus—are present.

It is easy to realize, from this condensed summary of the pathological changes in affections of the labyrinth, how complete destruction of the different structures may gradually

ensue, necessarily involving the foramina, oval and round, and all the nerve elements, until nothing remains save canals filled either with connective-tissue elements or granulation tissue with osseous formation, leading at last to obliteration of the spaces and apertures of the labyrinth. The auditory nerve is peculiarly liable to invasion by new growths (Virchow), and Politzer considers that, of all the nerves of sense, it is the one most susceptible to impressions due to systemic conditions and circulatory as well as infectious influences. Sarcomatous, fibromatous, and neuromatous growths are found, amongst others, in the internal auditory canal. Such tumours unavoidably affect the nerve by pressure.

With regard to the central origins of affections of the auditory nerve, we have to look to the fourth ventricle and the presence of any form of growth, or an effusion either of serum or pus, in it or its neighbourhood. That the sense of hearing is in greater part situated in the central lobe, and more particularly in the superior temporal gyrus of this lobe (Ferrier), is generally accepted, as also that the auditory nerve is in relation with the auditory centre of the cortex through the lower fillet of the opposite side, and thence by means of the posterior tubercle of the corpora quadrigemina and internal geniculate body to the medullary fibres of the cortex (Baginsky). It is thus probable that a lesion of the adjoining parietal or occipital lobe may encroach upon, invade, or inhibit the hearing-centre, and any affection of the latter will affect the hearing. Disturbances of equilibration, whether intralabyrinthic, in the perilymph or endolymph, or intracranial, from ventricular distension and fluid-pressure, will also cause disturbance of audition.

Etiology.*

Any source of interference with labyrinthine equilibration is apt to affect the auditory nerve. We find such extraneous causes in altered vascular tension due to anæmia, and still more so if such anæmia be associated with any local transuda-

See also remarks on the Causation of Tinnitus and Vertigo.

tion, serous effusion, or blood extravasation. The same result follows from cervical and mediastinal tumours through pressure on the cervical veins and from cardiac disease. We shall refer to this cause again in dealing with tinnitus. The vascular abnormalities brought about by gout, rheumatism, and uræmia have a like effect, and the vascular disturbances which attend upon Bright's disease and diabetes frequently provoke irritations of the auditory centre and the auditory nerve, while labyrinthic hæmorrhage and extravasation are not uncommon. Fractures of the base of the skull and other traumatisms directly affect the nerve and labyrinth. As a secondary consequence of hæmorrhage, effusion, and exudative changes in the labyrinth, tumours, and osseous degeneration, come atrophic changes in the auditory nerve, either from pressure or degeneration. Distinct from such morbid processes in the labyrinth are those central sources of auditory nerve disease such as cerebral tumour, meningitis, and hydrocephalus. Politzer has emphasized the influence of embolic softening as a cause of auditory nerve degeneration. Several other causes of internal ear affection we have already enumerated (*vide* chapter on Etiology). Syphilitic degenerations in the internal ear are, comparatively speaking, uncommon. When they do occur, they are the consequence of exudation and hyperplasia, with the formation of new growth in the labyrinth.

It is worthy of notice how rarely there is direct extension of disease from the tympanum to the labyrinth, and the researches of Eichler, disproving the former idea of a direct connection between the vascular supply of the tympanum and that of the labyrinth, in great measure explains this immunity of the internal ear from participation in the acute and many of the chronic forms of otitis media. The exception to this rule in the case of children is explained by the more free anastomosis between the middle ear and the labyrinth in the child, as also between the labyrinth and the cranial cavity, and, as Politzer has shown, because the labyrinthine fluid and the cerebro-spinal cavity communicate more freely in the instance of the child than in that of the adult.

Symptomatology.

The clinical division of affections of the labyrinth and auditory nerve into anæmic, hyperæmic, hæmorrhagic, hyperplastic, and exudative, is founded on the pathological conditions which have been here described. As in all these states tinnitus and vertigo are prominent symptoms, apart from the deafness which either precedes or is attendant upon them, we will consider first the general clinical facts bearing upon the etiology both of tinnitus and vertigo, necessitating also a reference to those physiological and pathological conditions which influence our prognosis and treatment.

Tinnitus Aurium.—This symptom is found to be present in almost equal proportions in the two sexes. It is rarely complained of by children. The youngest patient we have had was three years old, and two were aged four and seven respectively. In the child of three years the cause was turbinal hypertrophy; in the other two, meningeal complications were present in the one case and tonsillar hypertrophy in the other. Tinnitus is more frequent in patients of middle life, between the years of twenty and fifty. Out of 300 cases analyzed, two-thirds were between twenty and sixty. The noises complained of vary, the most common being the following: A buzzing sound as of the roaring of the sea or the rustling of trees, the singing of a kettle, the blowing of bellows or a furnace, a bee humming, as of the air in a shell, puffing, a thumping, a continual beating, crackling in the head, a train, the vibration of a metal, the whistle of a steam-engine or its puffing, a constant hammering, rushing water, a drumming, rain falling, a booming, distant thunder, chirping of birds, a waterfall and mill-wheel, tinkling of bells, and musical sounds. We have given this description of the various sounds in the patients' own words. About one aural patient in every three suffers from tinnitus. In the great majority both ears are affected, and when the noise is heard only in one ear it is the left that is most frequently complained of.

Causation.—Of all the ascribed causes, cerumen in the external auditory canal, chronic hypertrophic rhinitis with

abnormalities in the nasal cavities, and catarrhal states of the naso-pharynx, are by far the most frequent. Next to these we would place mental worry and overstrain. Sea-bathing is responsible for the occurrence of tinnitus in a fairly large number of cases. Long residence in the tropics not infrequently produces conditions which lead to tinnitus. The effects of the menopause also operate in the causation of tinnitus, as do various disorders of the genitalia in women. Gout, with its various complications, and rheumatism, chronic alcoholism, syphilis, the exanthemata, pregnancy, Bright's disease—all tend through their effects on the auditory apparatus to produce this symptom. Amongst other causes may be mentioned carious teeth, the concussion from gun-firing, and the administration of quinine. When we remember that disorders of the middle ear, either in the tympanic cavity, its drum covering or ossicles, or the Eustachian tube, are present in three-fourths of the cases in which we find tinnitus a symptom, we recognise how important is this clinical fact in its bearing upon treatment. It may be fairly estimated that not more than one in ten of the patients suffering from tinnitus and deafness complain of vertigo, and in fewer still have we the characteristic symptoms grouped under the head of Ménière's disease. In a few we have such symptoms as hyperæsthesia acustica, or hyperalgesia, paracusis loci, and reduplication of sound. Ocular disturbances, with associated retinal pathological states, are occasionally present.

Preliminary Examination of a Case of Tinnitus.—A careful first examination on the lines already indicated should enable us to differentiate not only a tinnitus which is due to an aural complication, whether in the external, middle, or internal ear, or possibly in two or all of these parts of the auditory apparatus, but also to satisfy ourselves as to the presence of any extra-aural sources of the symptom which may tend to aggravate and perpetuate it. The tuning-fork and the Galton pipe come in as our most valuable aids to differential diagnosis. This has been dwelt upon already (see 'Tuning-fork in Diagnosis'). To this end the heart and the vascular as well as the nervous system have to be carefully examined (*vide* 'Vertigo').

Tinnitus with Unimpaired Hearing.—A tinnitus in a case in which the hearing is not affected will at once indicate the necessity for a cardiac examination. It may, for instance, be associated with general anæmia, and the attendant hæmic murmurs will help to explain the cause of the tinnitus as being located in the vessels of the labyrinth. An inefficient systole and the frequent attendant irregularities of rhythm are not uncommonly found in these cases of overworked and worried men and women. Here a 'pulsating' tinnitus is occasionally complained of, always worse on first lying down at night or on awaking in the morning, and frequently disappearing during the daytime. Such a tinnitus may be materially modified or altered by pressure made under the ear, behind the condyle of the jaw, or over the vertebral artery in the suboccipital space. Again, both aortic and mitral insufficiency are at times attended by tinnitus. Also with unimpaired hearing it is often present (the sound generally being of a low hissing or rustling character) in slight catarrhal conditions of the naso-pharynx in which the respiration through the nose is obstructed, especially at night, when the patient has a tendency to sleep with the mouth open. The same may be said of cases in which we find slight congestion and hypertrophic enlargement of the turbinates.

In these cases of normal hearing, if there be indications that the nervous system is involved, our first survey will include an examination of the retina and the nerves of special sense, the testing of the knee and ankle reflexes, a search for oculo-motor symptoms, signs of paresis or motor disorders, areas of hyperæsthesia or anæsthesia, any contractions, contractures, or spasms, atrophic or hypertrophic muscular changes, localized neuralgias, and hallucinations. It will also include dynamic tests and those usually employed for equilibration. An examination of the urinary secretion is obviously essential in all cases of this character.

Physiological and Pathological.—To better differentiate the sources of tinnitus, whether cerebral, in the auditory nerve, or in the labyrinth, we may best deal with these categorically, as follows :

(a) *Cerebral impulses* originating in the temporal lobe, or superior temporal gyrus, the cerebellum or the auditory nuclei (in the medulla or pons), and referred as impressions to various situations, as the labyrinth or certain parts of the head. Such acoustic impressions may or may not be attended by deafness. These impulses may be associated

with lesions in these areas—as tumours, apoplexies, effusions, thrombi—or possibly lesions in the adjacent portions of the occipital or parietal lobes, or they may result from reflected irritations of any of these parts.

In such cases we are likely to have some evidence of the implication of other nerves of sense in reflex disturbances, muscular paresis, cutaneous anæsthesia or hyperæsthesia, or in oculo-motor symptoms. Such causes as apoplexies, effusions, thrombi, or cerebral lesions, acting by inhibition, are most likely to reveal themselves in objective signs in the parts in correspondence or associated with these cerebral centres. It is probable that in such reflected excitations we have an explanation of a tinnitus without deafness, as in cases of dental caries, dental periostitis with neuralgia, spinal tabes, uterine disorders, and in the functional sexual disturbances of the menopause or pregnancy (though in the latter it is more often to be attributed to arterial tension and hæmic changes).

(b) *Auditory nerve impulses* due to irritation, direct or reflected, in any portion of the auditory nerve. This class would include atrophy, sclerosis, traumatism, vaso-motor (dilator or constrictor) effects, morbid blood-supply, as in uræmia, anæmia, or the circulatory changes which occur during pregnancy. These latter causes may also operate in the previous class of case. We may expect to find more direct evidence of a lesion or excitation in the auditory nerve itself. In hyperæsthesia, the hypersensitiveness and pain attendant upon certain sounds; in traumatism, the history of some injury, as a blow on the ear, a railway collision, a nasal fracture; in sclerosis and atrophy, the absolute deafness and the negative response to the watch or tuning-fork, even by conduction, added to the history of pre-existing aural symptoms and progressive deafness or vertigo; in irritation of the vaso-motor centre, vaso-motor disturbances of the labyrinth due to reflected excitations arising in the spinal cord or in the nuclei or branches of the fifth nerve; in spinal neurosis, spinal and ganglionic irritation, oculo-motor symptoms, visual disturbances, gastric crises, headache, possibly thyroid changes, flushings of the

face, eruption of the wisdom teeth, dental neuralgia, ocular and laryngeal migraine.

Urine of low specific gravity with a radial pulse of high tension, albuminous urine or that charged with excess of uric acid, the characteristic uræmic complications with the associated altered blood of pregnancy, require only to be remembered as coming under this class to secure their detection on examination.

Impulses originating in the periphery of the auditory nerve may be due to (1) increase or diminution of labyrinthine pressure, increase or diminution of, or encroachment upon, the perilymph or endolymph, from abnormal pressure on either of the fenestræ; this latter cause would include rigidity of the membrane of the round opening and fixation of the stapes against the oval opening. (2) Vascular changes: increase or diminution of blood-pressure, frequently associated with cardiac disease, hyperæmic, anæmic, or toxæmic states of the blood circulating in the labyrinth, apoplexy, and extravasations. (3) Morbid nerve conditions: hyperæsthesia, paresis (organic or functional), atrophy, sclerosis, traumatism. (4) Rheumatic, gouty, or syphilitic states of the walls and vessels of the labyrinth. (5) Reflected disturbance, as occurs in uterine disorders, pregnancy, gastric derangements, disorders of the liver, flatulence, spinal neuroses, dental, nasal, and ocular irritations involving the fifth and facial nerves. Here we confront more distinctly local causes of tinnitus, for such auditory nerve-end excitations are usually associated with abnormal states of the tympanum, involving the ossicles, the drumhead, and the oval and round openings. Such tympanic changes are readily discernible by the methods already described. In many cases, though we have no doubt that the auditory nerve is affected, the drumhead preserves its translucency, and there is but slight deviation from its normal appearance. A fair degree of hearing is consistent with the presence of severe tinnitus and vertigo, and there may be no proof of gross middle-ear changes. It is in such persons that we are likely to find anæmic or hyperæmic conditions, increase or diminution of blood-pressure, or some toxic quality in the blood which influences the vascular

tension. Such hæmic sources of tinnitus are frequently the forerunners of an attack of Ménière's apoplectiform seizure. Nerve-end lesions in the labyrinth are commonly the cause of loud noises, and it is not unusual for the patient to describe two or three different kinds, one being a musical tone or note. Gout, rheumatism, and syphilis have each their characteristic clinical signs enabling us to associate these affections with the tinnitus. Various visceral neuroses arising in the abdominal organs produce reflected disturbances in the labyrinth, and not uncommonly some form of dyspepsia with hepatic inactivity and flatulent distension of the bowel are present. That the auditory nerve-irritation may have its origin in dental and nasal irritation is not to be forgotten.

(c) *The intra-tympanic muscles.*—We may, for clinical purposes, place under a distinct heading tinnitus arising from irritations in the tensor tympani and stapedius. Such interferences would include any spasm of these muscles or reflex irritation of them transmitted from the facial or trigeminal nerves. Here the tinnitus arises from the effect on the equilibration of the fluid of the labyrinth. The muscular spasm may be due to some direct or reflected irritation in the fifth or facial nerve. There may be no indication of middle-ear affection, and hearing may be but slightly influenced, unless middle-ear changes have been pre-existent.

(d) *Middle-Ear Changes.*—We are familiar with a distinct cause of tinnitus through irritations transmitted by pathological changes in the middle ear and altered conditions of equilibration of the air in the tympanic cavity. This class includes enervation of the tubal muscles of the Eustachian tube, and altered relations between the air in the tympanic cavity and the blood in its vessels or those of its membrane; also pathological states of the cavity of the tympanum and the drumhead, embracing atheromatous changes in the arteries, aneurysmal dilatations, blood extravasations, venous congestion within the lateral sinuses, disease of the mastoid cells, and disease of the petrous portion of the temporal bone, exudations, and tumours.

Here we find one of the commonest causes of tinnitus and deafness, the consequences of the altered relations of drum-

head and ossicles, including that rigidity and immobility of the former, with ankylosis and fixation of the latter, which are the result of chronic otitis media, and in which the symptom *paracusis Willisii*, or defective power of synchronous differentiation of sounds, is present. The objective signs, both middle-ear and nasal, as well as pharyngeal, which explain Eustachian interferences and account for the altered equilibration as well as the disturbed vascular conditions, have been fully dealt with. We include also those more serious middle-ear complications which attend upon endoarteritis, endothelial changes in the bloodvessels, and atheroma, as local apoplexies and extravasations, exudative and hyperplastic effusions, congestion of the venous sinuses, which latter arise from pressure or from cardiac disease. Defective equilibration will also arise from obstruction, pulmonic circulation, and deficient oxygenation; and, lastly, there are the still graver inflammations of the mastoid and petrous portions of the temporal bone, with all their serious local signs and constitutional symptoms.

(e) *External-Ear Irritations*.—In the external auditory canal occur those irritations, some of which act directly through its nervous supply and communications, while others do so rather by the influence they exert on the sound waves or by pressure on the membrana tympani. Inflammation and abscess, eczema, otomycosis, hyperostosis, exostosis, and othæmatoma, are examples of the former, and cerumen or foreign bodies of the latter. Though it may seem that such causes of tinnitus are so obvious that they cannot possibly be overlooked, it is well to emphasize the danger of doing so. The tiniest particle of cerumen on the membrane—an almost imperceptible semi-transparent husk of hayseed or other particle of foreign matter—is sufficient to start a tinnitus, and this symptom may also attend upon slight inflammatory conditions of the canal, especially when they are in the vicinity of the membrane. Such a case as the following is illustrative of the necessity for caution:

A lady, aged sixty, had for a considerable time suffered from a most distressing tinnitus, 'like a steam engine,' heard almost entirely in the left

ear, through which, she complained, 'shooting pains occasionally darted.' The right ear had been deaf since childhood. She suffered from occasional attacks of giddiness. The acoumeter in the right ear was heard at less than two inches, and the watch not on contact. The meatus contained a plug of cerumen, the removal of which caused but a little difference in the hearing. On exposure of the membrane, an old perforation was seen in Shrapnell's, and there were evidences (with Siegle's speculum) of long-standing contractions and adhesions. In the left ear the hearing was better than in the right, the watch being heard well on contact. In the canal was a plug of cerumen and dead cuticle, which was very difficult to remove. This pressed down on the drumhead, the walls of the canal being in an inflamed and irritable condition. When the cerumen and cuticular lining were removed and the tympanum inflated, she heard the watch at 4 inches well and the acoumeter at 15 feet. Her tinnitus was gone. The case shows that it is possible to overlook such simple causes of deafness, giddiness, and tinnitus.

(f) *Therapeutical Causes*.—Under the head of therapeutical causes of tinnitus we include the action of certain drugs, as, for example, ergot, nitro-glycerine, alcohol, ether, quinine, salicine, caffeine, apomorphine, nitrite of amyl, tobacco, iodine, iodoform, chloride of barium, digitalis, convallaria, atropine, veratrine, duboisine, gelsemine, jaborandi, pilocarpine, monobromide of camphor, hydrobromic acid. Some of these drugs may act by direct stimulation of the auditory nuclei in the medulla, as caffeine, gelsemine, iodoform, salicine, and quinine; others, as digitalis, jaborandi, nitrite of amyl, chloral hydrate, by their effects on the vaso-motor centre; others, as quinine, digitalis, and convallaria, by their secondary effects on the auditory circulation through their action on the heart. Quinine occasionally causes such vascular disturbances in the labyrinth as to bring about symptoms of Ménière's affection or 'quinine intoxication' (see chapter on Causation). The tinnitus of fever is almost invariably transitory. This is our view after eleven years in a large fever hospital.

Both alcoholic excess and over-indulgence in smoking certainly increase, if they do not occasionally cause, tinnitus, and intensify the loudness of the noise.

(g) *Aural Hallucinations*.—Quite apart from such causes of tinnitus are true aural hallucinations. Subjective impressions arise in the psycho-sensorial brain-centres, having

no objective cerebral or aural source of origin. Such hallucinations may become insane hallucinations. The latter may be divided into two distinct forms: (1) Hallucinations which arise subjectively in the brain when the aural apparatus and auditory nerves are healthy. (2) Hallucinations which are secondary to objective changes in the aural apparatus, and in which a tinnitus is developed that leads up gradually to a fixed illusion. It is essential always to keep such hallucinations or aural illusions apart, as phenomena quite distinct from tinnitus. They are analogous to ocular illusions or spectra. We refer to 'heavenly voices,' or 'music'—a symptom associated with epilepsy and hysteria. The same observation applies to 'alcoholic psychoses.' The entire auditory apparatus is healthy, and the hallucination is quite independent of any acoustic trouble. 'Instances do occur where what was originally a tinnitus, depending on some morbid state of the aural apparatus, eventuates in a condition of hallucination—that is, the individual so affected may, from a lowered state of the nervous system, or as the result of long-continued irritation, come to consider the subjective noises as real and depending on external causes, and they may act thereon' (Ringrose Atkins). This constitutes an insane hallucination, though it may not depend on any morbid condition in the psycho-sensorial brain areas. This is what occurred in the following case:

After marriage a lady fell into ill-health; she became despondent about her ear and the tinnitus from which she suffered. Gradually she developed delusions with regard to the ear, screaming violently and being with difficulty controlled. This state gradually merged into one of ordinary dementia, but in which the prominent idea was that the ear was the source of all her trouble. 'I have known,' says Ringrose Atkins, 'a woman in no way insane who, as the result of tinnitus, firmly believed that an insect had entered into her ear and penetrated her brain, and that it was constantly biting the latter, as she heard it within. The morbid belief raised the purely somatic subjective sensations to the level of an "insane hallucination."' He also cites a case of 'a man who was in a condition of deep depression from tinnitus, which took the form of "crackling" all over his head, and which was well-nigh unbearable.' Another suffered from athetosis. -

Diseased Teeth as a Cause of Tinnitus.—It is important not to overlook the teeth as a possible starting-point of tinnitus. This cannot surprise us when we remember the numerous communications of the trigeminus with the other cranial nerves and their nuclei. Such aural reflexes are not of frequent occurrence. We might expect to find them more frequently with eruption of the wisdom teeth. But indirectly, through loss of sleep caused by facial neuralgia, headache, and the nervous prostration which we frequently find present with painful carious stumps, tinnitus may be induced by dental periostitis and caries. At least, the teeth, in any persistent case of tinnitus in an enfeebled person, should not be above suspicion and inspection. Indeed, it is well to seek for any collateral source of excitation in the other cranial nerves as well as the auditory itself. It is conceivable that the prolonged irritation caused by astigmatism and its secondary consequences in persistent headache, vertigo, and nausea, might start in the ear such a subjective phenomenon as tinnitus. As a fact, we have known, whether as a coincidence or otherwise, on several occasions in a sufferer from astigmatism tinnitus to be present.*

Diagnosis.—In arriving at a differential diagnosis in any case of tinnitus, it will assist us to keep in mind these different origins of irritation, whether direct or reflected.

Prognosis.—We have to confess that it is often difficult to define the grounds on which we arrive at a prognosis in certain cases of tinnitus, and to differentiate those in which we may hope to either relieve or cure. In the category of *incurable cases* we may fairly include those which attend on cerebral growths, lesions, and degenerations, though cerebral effusions may yield to time and special remedies, as the iodides and mercury. Also we may regard as hopeless atrophic, sclerotic, degenerative, and traumatic lesions of the auditory nerve; and in the labyrinth, hyperplastic and exudative changes or extensive extravasations, whether of traumatic, rheumatic, gouty, or syphilitic character, in its walls or vessels. This would include aneurysmal and atheromatous conditions of the auditory arteries. Turning to the

* 'Dental Reflexes,' *Dental Record*, September, 1890 (Author).

middle ear, we cannot hope to effect any good in those cases of chronic otitis media in which there are gross changes in the tympanum involving the intra-tympanic muscles and ossicles, and in which there is a history of progressive deafness, with closure or occlusion of the Eustachian tube. A similar conclusion must be arrived at in the case of exudation and tumours in the mastoid cells, or disease of the petrous portion of the temporal bone consequent upon chronic suppurative otitis media. Where hallucinations are attendant upon or follow gross changes in the middle ear and labyrinth, they are, as a rule, permanent.

The tinnitus which we may reasonably hope to affect by treatment, and *considerably relieve, if not permanently cure*, we may divide under these heads: (1) Tinnitus arising out of any reflected irritations of the auditory centre or auditory nerve, and which are due either to toxic, vaso-motor, or vascular disturbances in the auditory areas. (2) Tinnitus arising out of simple hyperæmia of the labyrinth, or that which is secondary to such fevers as influenzal, malarial, puerperal, so-called cerebral, and zymotic. (3) Tinnitus consequent upon temporary alterations of the labyrinthine equilibration, whether due to altered condition of tension of the fenestræ or increase or diminution of blood-pressure, associated with cardiac functional disorders. (4) Tinnitus consequent upon abnormal states of the intra-tympanic or the tubal muscles, the result of innervation, paresis, or spasm. These abnormal muscular conditions, through their effects on the membrana tympani and ossicles, disturb the labyrinth through the tympanic openings. (5) Tinnitus which occurs in that large class of sufferers from obstruction in the Eustachian tubes, collapse of their walls, and stenosis. (6) Tinnitus which is due to causes arising in the external auditory canal. (7) That which owes its presence to the effects of drugs. (8) Aural hallucinations which occur independently of any acoustic or cerebral trouble, and which may be associated with visceral or pelvic neuroses. Such hallucinations, if they become insane hallucinations, disappear with the mental alienation.

Affections of the Female Genitalia.—We have not found

that tinnitus or vertigo can be directly traced to uterine or adnexal disorders as often as some appear to think. On the other hand, there are cases in which both these symptoms are undoubtedly due to disordered genital function or disease in the pelvic viscera. Such a direct consequence we find during pregnancy, and this we can readily understand from the condition of the blood at the time, or the renal complications, or, again, from pressure. With large myomata of the uterus we have the vascular drain and the anæmia resulting from hæmorrhage, or, again, the consequences of pressure. In extreme degrees of displacement, with its complications, the local effects on the pelvic nerves and circulation cause vaso-motor changes and reflex nerve irritations, the menorrhagia or metrorrhagia of the menopause, with its effects on the heart and blood. All these are sufficient to cause either tinnitus or vertigo. During the menopause it is that the reflex disturbances are most likely to affect the hearing, and noises 'in the head and ears' follow exhaustive discharges, influencing the blood-pressure and causing those sudden changes so dangerous to the integrity of vessels elsewhere than in the uterus, as, for example, the retina, the kidney, and the lung. It is no matter for surprise that, under these conditions, we meet not only with subjective aural phenomena, but the graver accidents in the labyrinth which attend upon apoplexy, and are grouped under the name of Ménière's disease. It is in these cases of the menopause that the free administration of the bromides, with hydrobromic acid and ergot, or sclerotic acid, hydrastia or hydrastinine, with lupuline, do so much good, and in high-tension cases the internal administration, as well as by subcutaneous injection, of pilocarpine. These remedies should be backed up by attention to the liver and portal system by salines, vegetable cholagogues, and the occasional administration of a mercurial.

Aural Vertigo.—Many of the causes which give rise to tinnitus operate also in producing vertigo. Thus, we find this symptom following from the same naso-pharyngeal affections and abnormalities that cause tinnitus. The removal of adenoid growths, hypertrophied turbinals, and

the rectification of septal deformities will often cure attacks of giddiness associated with deafness. The same may be said of growths in the tympanum, blood and lymph effusions, or hypersecretion of mucus in the tympanic cavity. Thus there are extra-tympanic and intra-tympanic causes of vertigo, apart from those which follow from injuries, abnormal positions and conditions of the ossicles, such as impaired mobility, stapedia fixation, and ankyloses. We have often associated with these conditions tubal obstruction or closure. Such primary causes may produce vertigo by disturbance of equilibration in the labyrinth and irritation of ordinary nerve-ends, without any co-existing morbid conditions of the labyrinth itself. Examples of vertigo, the result of pressure and irritation in the middle ear, are seen in the giddiness produced by syringing, especially with too cold water, and in that which follows the forcing of fluid through the tympanum in cases where the drumhead is perforated. Here it is probable, as Weber-Liel demonstrated, that the vertigo with faintness and sickness follow as the result of pressure on the exposed stapes. Such pressure commonly results from growths in the cavity of the tympanum, and is not uncommonly cured when such growths are completely and permanently removed. We have seen the most aggravated cases of vertigo speedily relieved after removal of granulation tissue and cholesteatomatous growths which filled the tympanum. We find vertigo and tinnitus attacking patients who suffer from cardiac disease, anæmia, diabetes, albuminuria, tabes, gout, and during pregnancy, in whom the hearing may be perfect, and where there is no evidence of anything save a functional derangement of the labyrinth. We have known similar attacks of vertigo with noises follow upon great and continuous mental overstrain, especially if the person be at the same time anæmic. In all these cases the vertigo varies in its degree of severity, from a transient dizziness to an inability to stand, or a tendency to fall and reel to either side. There may or may not be nausea and actual sickness. In one class of case we find a reason for the attacks in the nasal, naso-pharyngeal, external auditory, and tympanic conditions.

The extensive nerve connections in the naso-pharynx, motor and sympathetic, through the cerebro-spinal nerves and sympathetic ganglia, and the distribution of these nerves to the several vessels supplying the large vascular area which includes the entire auditory tract and naso-pharynx, are sufficient anatomical grounds on which to explain the healthful physiological relations maintained between the nasal respiratory function and the circulation in the naso-pharynx, tympanum, and labyrinth. The equilibration of the labyrinthine fluid and the inhibiting function of the hearing-centre and cerebellum, including the efficient control of any perverted impulses which may be excited through morbid processes involving the peripheral nerve, have a correlation which these anatomical relations explain.

Clinical experience proves that mere mechanical obstruction in the nasal passages and its interference with the ventilation of the tympanum does not, as a rule, cause vertigo. It is not common to find it in cases of nasal polypi, and vertiginous symptoms are absent where there is congenital malformation of the pharyngeal wall and hypertrophy of the pharyngeal tonsil. Indeed, we constantly meet with extreme deviation of the septum and turbinal hypertrophy without any vertiginous symptom. It would appear that such a consequence follows when the obstruction leads indirectly to pressure effects on the labyrinthine fluid and disturbance of equilibration, or to such middle-car changes and associated labyrinthine disturbance as to cause irritation of the auditory nerve-ends. In other cases of vertigo local aural causes have to be excluded, and we find that the peripheral or central auditory nerve irritation is excited by anæmic and dyspeptic states, by pneumogastric or sympathetic irritation, or other causes, such as those we have enumerated. We have to remember that aneurysms of the basilar and vertebral arteries also cause vertigo, through their direct effects on the cerebellum, and vascular disturbances in the labyrinth. Quite apart from all such causes of labyrinthine vertigo are those morbid changes and processes in the labyrinth affecting the endolymph or perilymph, its vessels and structures, which we have enumerated, as well as the

vertigo which follows upon pathological degenerations in the auditory nerve. A vertigo consequent upon such morbid labyrinth and nerve conditions will usually have associated with it tinnitus, and always some degree, more or less, of deafness, and it is not difficult with care to locate its source. Next, causing vertigo, we have those cerebral and cerebellar diseases, tumours, abscesses, effusions of blood or lymph, toxic causes, and reflected irritations through the spinal cord and cerebral nerves. Lastly, we may include, as in the case of tinnitus, the giddiness which follows upon the administration of some drugs, notably quinine (see Tinnitus).

Apoplectiform Vertigo (Ménière's Disease).—Clinically, quite distinct from any of these forms of vertigo is that which we term *apoplectiform*, and which is associated with the name of Ménière. Here we have certain distinctive features: one ear is generally affected, the attack comes on suddenly, there is giddiness, which in some cases ends in reeling, the patient falling to the ground, and in the more severe attacks there may be partial unconsciousness, the vertigo lasting for varying periods of time. Occasionally these attacks occur in bed, when the room, or the bed itself, appears to move. The attacks, however, are more rare in the horizontal than in the vertical position. The tinnitus, should it have pre-existed, is greatly aggravated at the time. Sickness attends on the paroxysms. We may take the following example as a typical case:

W., aged seventy, had had absolute deafness of the right ear for nine years, for which no cause could be assigned. Neither the watch nor the acoumeter was heard on contact in this ear. One month previously, while in a tram-car, he felt a sudden flushing of the head. This was followed by a sensation of reeling and sickness. Then there was a sound 'as if he were going through a railway-tunnel,' and he became suddenly deaf. On his return home he vomited. Previously to this attack, and still persisting at the time of it, there had been evidence of some facial nerve paralysis from exposure to cold or draught. At that time he could not close his left eye, and there was partial anæsthesia of the right side of the face. On examination, neither watch nor acoumeter was heard in the recently-affected left ear. The tuning-fork was hardly audible on the head, being rather felt than heard, any sound dying completely away on closure of the ear. He was unable to stand unsupported, falling towards the *left* side. On placing him with his back to me, and making him turn rapidly

to the left, he staggered ; not so on turning to the right. He was unable to write his name legibly, from inability to hold the pen and form the letters.

He was placed on bromide of strontium, hydrobromic acid, and ergotine, with subcutaneous injections of pilocarpine. A month subsequently he had greatly improved ; he was able to walk without a stick, the tuning-fork was heard much better, the watch was heard on contact with the ear, and the acoumeter at $2\frac{1}{2}$ inches. He could then write legibly, and his hand was comparatively steady.

Guye of Amsterdam, grouping all those cases in which a sensation of vertigo is caused by abnormal irritation of the nervous terminal apparatus of the semicircular canals under the head of Ménière's disease, notices that the first sensation is one of rotation around a vertical axis and toward the *affected side*, followed, before the vertigo is complete, by a sensation of rotation about a transverse axis, forward and backward, the vertigo then becoming complete, and the patient swoons, with or without loss of consciousness and vomiting. Guye also calls attention to the tremulous character of the handwriting in the early stages of Ménière's disease.

Eckert, reviewing all that had been written up to 1885 on the subject, took the same view of the causation of Ménière's disease.

'The appearance,' he said, 'of the various symptoms is in most cases attributable to a diseased state of the terminal apparatus of the acoustic nerve in the labyrinth. It is only in rare instances that these are called forth by pathological changes in the adjoining nerve-centres. Pathological changes of conditions in the middle ear and in surrounding structures, producing a change in the intralabyrinthine pressure, may call forth a similar train of symptoms. The symptoms are induced by an irritation of the labyrinthine organs or their nervous centres. Complete destruction of the same seldom calls forth a loss of function. Disturbances of co-ordinate motion may be absent in pronounced chronic or acute affections of the labyrinth. Constitutional diseases, such as syphilis, leukæmia, epidemic parotitis, and tabes, are recognised factors predisposing to the development of Ménière's disease.*'

We thus see that these views include a variety of etiological conditions under the same term, and render the correct application of it to a distinct pathological occurrence impossible ; for they must embrace in connection with it every source of irritation of the auditory nerve-ends, as well as those primary or secondary causes of pressure in the labyrinth.

* *Archives of Otology*, June to September, 1885.

which arise either in the other portions of the auditory organ or in the labyrinth itself. *We reserve the term for sudden apoplectiform seizures which are consequent upon effusion into the labyrinth of a hæmorrhagic, leukæmic, or syphilitic nature, keeping quite distinct all other sources of interference with its nervous apparatus or equilibration.*

We have had patients in whom the vertigo occurred in bed, and was followed by most severe vomiting. While the deafness may not be severe during the earlier attacks, it generally increases in intensity as the vertiginous seizures become less frequent. In our experience syncope or unconsciousness are not as frequent in the apoplectiform seizures as they are in those attacks of vertigo which are attendant upon intra-tympanic and labyrinthine growths.

I would describe as the most frequent *predisposing causes* of this special form of vertigo: anæmia, alcoholism, gout, syphilis, rheumatism, and senile arterial changes. The *complications* most frequently met with are: albuminuria, uric acid excess, hydræmia, rigid and tortuous vessels, endocardial changes, cardiac hypertrophy with dilatation, closure of the nasal passages from hypertrophic changes or malformation.

The *warning symptoms* are mainly such as we might expect from these clinical and pathological conditions—*i.e.*, sense of fulness in the head, occasional buzzing in the ears, some slight deafness of a more or less periodical nature, headache, occasional transient attacks of vertigo, susceptibility to temperature and changes of atmosphere, attacks of confusion in thought and memory.

The age at which the attack is most likely to occur is after fifty, in the majority of cases after sixty. The exciting causes most to be feared are: mental strain in work, mental worry in business, grief, night-nursing, much railway travelling, stooping occupations, the menopause, alcohol, sedentary life, bathing in cold water, sea-bathing, hot baths, and pregnancy.

Severe Aural Vertigo treated by Operation.—A patient, aged sixty-two, suffered from diminution of hearing from childhood. This he traced to an attack of otitis which

followed measles, when there had been a discharge from the ears. This ceased in the right ear, but continued for some time in the left, from which, as far back as 1872, a polypus was removed. Again there was some chronic discharge. In 1887 he consulted a distinguished physician for recurrent attacks of vomiting and giddiness. His ear was examined, and it was found that there was regrowth of the polypus. He remained under able aural treatment for nine years, being operated upon on several occasions for recurrent growths. Occasionally he was troubled with severe tinnitus. In April, 1898, he was again attacked with severe vomiting, attended by migraine. The sensation he described as 'the floor of the room coming up and the ceiling going down.' On rapidly turning a corner, somewhat the same symptoms occurred. There were some associated visual disturbances, as, for example, seeing white and blue stripes, something, as he said, like those on a flannel shirt. If he looked at his dressing-gown, which was striped, he immediately became giddy, and as he lay in bed the room occasionally appeared to move round. Of late these attacks had become worse, the sickness more incessant, and he had to live principally on milk and soft food. He complained of some pain, radiating over the left side of the head, and he also had attacks of general headache. He next consulted two distinguished neurologists. One advised a cranial operation; the other did not give an opinion as to its advisability, and said little save that he thought that he might undergo it. This was at the end of 1898. On the 20th of the previous December he had had a very bad attack in a public lavatory, where he had become unconscious, and had to remain in it for an hour and a half before he could be removed. When seen his general condition was as follows: He was led into the room requiring to be supported. He could not stand with his eyes closed, with his legs together, or with one leg raised. His gait was uncertain; he had rather a livid look; there were dilated veins on his face; his pulse was 60, feeble, and intermittent. The cardiac area of dulness was increased, the rhythm irregular, and the first sound feeble. There was considerable abdominal fulness, with hepatic enlargement.

On examining the right ear, absolute deafness was found to Galton's whistle and to conduction with the tuning-fork, but there was nothing special to remark about it further than that the tympanic membrane presented the usual appearance seen in old cases of sclerosis. In the left ear a new membrane had formed, which covered in the tympanum. On testing his vision, a high compound presbyopic astigmatism was discovered, which could be fairly corrected both for distance and reading by suitable lenses.

His last attack of vertigo occurred on January 23, 1899, at 7 a.m., and he had counted, from the bad attack in April, 1898, as many as twenty seizures of severe vertigo. It was decided that any cranial operation would, in his condition, be attended by the greatest risk. There was little doubt that the principal cause of his giddiness and migraine was to be found in some intra-tympanic growth. Still, we thought that the associated and uncorrected astigmatism might also play a part in its causation. We therefore advised that in the first instance the tympanum should be attacked from the meatus, its cavity opened, and any growth found there removed. This was done under ether and oxygen on January 30, 1899. The membranous covering was removed completely, and behind it a mass of granulation tissue was found and thoroughly curetted away. The bare cavity, when cleansed and dried, was filled with iodoform gauze. The patient gave the anæsthetist (Mr. Bakewell) rather an anxious time during the operation, and on the first occasion of removing the iodoform dressing an alarming attack of syncope with collapse necessitated a subcutaneous injection of strychnine and an inhalation of nitrate of amyl. There was a recurrence of this symptom on another occasion of dressing. Some three months subsequent to the operation he wrote a note, saying: 'I now tricycle from four to seven miles, have completely lost my giddiness, have a good appetite, and can eat anything.'

Before this we corrected his astigmatism for distance and near work. Up to a few months since he has been under our observation and that of his own medical adviser, who was

present at the operation. On a few occasions there was a tendency to reappearance of some granulations. These were treated with trichloroacetic acid. He has greatly improved in general health and appearance, and has been occupying an important public position, having acted for a year as president of a large public association. For all practical purposes his hearing is good.

For some time he suffered from gouty inflammation of the meatus of both ears, but when last seen he had not had a single attack of vertigo or vomiting since the operation. Lately his general health has been very good.

General Therapeutics.—As regards our treatment of pathological states, whether of the osseous or membranous labyrinth or its nervous apparatus, it must be, to a certain extent, empirical, and depend upon the correlation we are able to establish between such growths or degenerations, or nerve excitation, central or peripheral, and some special diathesis, specific taint, toxic elements in the blood, or neuroses arising out of affections of the circulatory organs, the abdominal or pelvic viscera. Proceeding upon these lines, we seek for evidences of gout, syphilis, and leukæmia, of increased arterial tension, of cardiac complications, rheumatism, diabetes, and chronic alcoholism. If we have to deal with the uric or oxalic diathesis, we treat it by diet and such remedies as lithia, sulphur, the alkalies, piperazine, uricidine, and resort to a special spa suitable for hepatic, urinary, and gouty states. We combine with this treatment the administration of one or more of the iodides, that of potassium or strontium by preference. We treat those sufferers in whom we find hepatic congestion with cardiac intermission by the judicious administration of salines with an occasional mercurial or vegetable cholagogue, at the same time that we give a vascular tonic, as digitalis, *strophanthus*, or *convallaria*. The total abandonment or strict limitation of both alcohol and tobacco is imperative. Where there is dyspepsia with flatulent accumulation, abdominal massage, properly administered, aided by a weak galvanic current applied over the large bowel, is often most effective, especially if there be constipation. With regard to vascular pressure

(in relation to vertigo and tinnitus), we find two clearly distinct classes of patients in which the lines of therapeutic action are broadly indicated. *In one group* there is slow and feeble action of the heart, perhaps attended by occasional intermittence; the pulse at the wrist varies in force and character—it may be full but compressible, or feeble and easily obliterated; the temporal arteries are dilated; the veins on the backs of the hands are unduly prominent; auscultation reveals an imperfect cardiac systole or diastole; the digestive powers are weak; there is a tendency to general nervous depression, and the occasional attacks of giddiness or faintness are evidences of cerebral anæmia.

It is in these cases we find most benefit derived from such drugs as iron and its combinations, digitalis, strophanthin, arsenic, quinine, strychnine, caffeine, ergot. The bromides have to be administered with caution, and it is a question if any temporary relief due to diminished irritability of the reflex and cardiac nerve-centres compensates for the depression which is attendant on their prolonged employment. The bromide salts of caffeine, zinc, and iron will, however, often be found valuable given in combination with other vascular and nerve tonics. Hydrobromic acid with quinine and pyrophosphate of iron is useful. Alcohol in such cases in any save very small quantities we have little doubt is injurious. The secondary dilatation of the arterioles which follows the use of alcohol, especially in the intervals between its administration, increases the tinnitus, while the cardiac irregularity and gastric disturbance which it frequently causes still further adds to the mischief. A small and defined quantity of alcohol taken with food in cases of weak appetite, or in the instance of anæmia an iron wine, is of service.

In the second group of cases there are the signs of increased arterial tension in the incompressible radial pulse, throbbing carotids, rigid temporal vessels, ocular phenomena, sleeplessness, headache, and sense of fulness in the head. Organic changes in some portion of the vascular system or the kidney accompany this increased arterial tension.

Aortic stenosis and mitral insufficiency, aneurysmal tumours, atheromatous degeneration, Bright's disease, contracted

kidney, are perhaps the most frequently met with as producing this high-tension tinnitus. In gout, rheumatism, chronic alcoholism, diabetes, and transitory glycosuria the same condition exists. It is present in females who suffer from erratic or suppressed menstruation, and is not uncommon at the menopause and during pregnancy. Excessive indulgence in tea may produce it. It is present also in the case of cerebral tumours and other degenerative changes both of the brain and spinal cord.

It is especially in this condition of increased tension that bromide of potassium and hydrobromic acid give most relief. Hydrobromic acid should be given in 30-drop doses, and may well be combined with such medicines as the bromides of sodium, or potassium, digitalis, or quinine, when these are indicated. The hydrobromate of cocaine is a useful agent for tinnitus in doses of a quarter to one grain. Pilocarpine may be tried. We have given hydrobromic ether, held in suspension by a little powdered acacia and glycerine, in 3 to 5 minim doses, with advantage. This, or pilocarpine solution, may be carried into the middle ear through the Eustachian catheter. Nitrite of amyl, nitro-glycerine, and nitrite of sodium will often afford temporary relief from the noise and throbbing in the ears. We have known inhalation of nitrite of amyl give great relief in several cases of tinnitus in which there was hydræmia with urine of low specific gravity.

In pilocarpine we have one of the most powerful agents for the reduction of vascular tension and for promoting the absorption of recent effusions or exudations. We have been using pilocarpine for over twenty years, and were among the first to administer pilocarpine in otological practice with these objects, using it then in cases of Ménière's affection. About the same time Politzer drew attention to its use subcutaneously in syphilitic exudations of the labyrinth, considering it to be of most service in these conditions. He did not regard it favourably in cases of otitis media arising out of diphtheria or scarlet fever, nor in cases of long duration subsequent to attacks of meningitis. Politzer's general conclusions were adverse to its use save in recent and severe cases of 'nervine deafness.'

We have always felt, and still feel, that if we can exclude gross middle-ear changes and irremediable labyrinthine lesions, and if we can trace a correlation between the aural subjective phenomena and increase of vascular tension with intra-labyrinthine pressure, or to recent effusions of blood, serum, or lymph, pilocarpine may rationally be expected to do good, but not otherwise. To employ it in cases of gross middle-ear changes and old organized exudative and hyperplastic degenerations is obviously absurd, and tends to bring the drug into disrepute. The strength of the solution is 2 per cent., and 3 to 6 drops are injected for each dose, care being taken to adopt proper precautions both to encourage perspiration and to prevent chill. In all cases, however, in which pilocarpine is injected, its effects must be carefully watched and noted during the earlier doses, so as to ascertain the effects of its administration on the individual.

The operations on the tympanum for relief of tinnitus are paracentesis, tenotomy of the tensor tympani muscle, excision of the tympanic membrane and ossicles. For the first operation, or that of a similar nature on the stapedius, whether for general sclerotic conditions arising out of adhesive inflammation or for immobility from thickening and degenerative adhesive conditions, the results have been so unsatisfactory that nothing definite can be said, and for the relief of deafness and tinnitus, with or without vertigo, it may be truly asserted that the results heretofore have not been equal to the first expectations held out from such operative procedures (see chapter on the Middle Ear).

Massage of the mastoid externally, with percussion practised daily for some time, influences for good patients who suffer from nerve deafness, and tinnitus is occasionally relieved by the use of the 'masseur' (Fig. 96). The mastoid massage has to be practised, by placing the patient seated on a chair opposite the operator, who stands and applies the soft ball of the thumb against the mastoid, using deep pressure, but not friction, in the movements, alternating these movements with percussion with the points of the fingers over the mastoid region. Menthol solution in oil may be used with the massage. Patient can himself apply some mild counter-

irritant, a good embrocation for the purpose being equal parts of the tinctures of capsicum and aconite, compound spirit of horse-radish and chloroform; or equal parts of solution of menthol and oil of mustard may be applied a few times in the day over the mastoid. Leeches or vesication may also relieve the noises.

Climatic effects have always to be carefully considered when it is possible to do so. Fairly high, dry, and sheltered localities are the best for such sufferers, especially if we combine with such a situation a porous soil. It is well worth the experiment to try a residence for some time in a resort in which change of scene and surroundings, in addition to the natural climatic surroundings, will produce both mental and physical effects. We have known tinnitus completely disappear after a stay in the Swiss Riviera or the Engadine, and much may be done by judicious selection of natural medicinal waters indicated according to the special needs of the individual.

Tinnitus and Vertigo.—We will make some special remarks on the treatment of these two foremost symptoms in affections of the internal ear, and indicate their therapeutics under two distinct heads: Those therapeutic measures directed to the correction of any defect in the structures of the organ of hearing itself, and those which are indicated for the relief of constitutional disorders of other organs which may either directly or indirectly affect the auditory nerve and labyrinth or the hearing-centre. In the first class we include the entire naso-pharyngeal tract, and the external, middle, and internal ear; in the second we include attention to hereditary and congenital conditions, temperament and diathesis, occupation, habits, and climatic influences, with rectification of visceral disorders and neuroses. Functional and organic cardiac affections have to be treated. The general health of the nervous system must be inquired into, and organic or reflex irritations or inhibitions corrected.

Both tinnitus and vertigo, as well as the accompanying deafness, are often cured by surgical attention to the septum, the turbinals, and the post-nasal space. Many striking instances have occurred to us in which hearing has been

greatly improved and tinnitus completely cured by turbinotomy and rectification of septal deformity. Remembering the anatomical connection of the nasal nerve, we can have no difficulty in recognising how irritations, starting in the nasal areas, may cause reflex vertigo through the relation of the ampullar and vestibular nerves to the cerebellum. That excess of sexual indulgence has in some persons a relation to chronically congested conditions of the nasal mucous membrane, and that the sexual act aggravates the tinnitus, is well known. In the middle ear we have to secure the patency of the Eustachian tubes, establish free ventilation of the tympanic cavity, and release imprisoned secretions in it, thus improving the position of the membrana tympani and the ossicles. At the same time we deal with parietic states of the intrinsic muscles of the middle ear and those of the Eustachian tube. The measures necessary to effect these objects must be continued for some time. When free nasal respiration has been secured, the middle ear is attended to by catheterization, the bougie, and intra-tympanic injections, in the manner described, as also by the use of massage, applied both externally to the mastoid and also to the auditory canal by Delstanche's or other masseur, and the application of the faradic current to the tympanic and tubal muscles. To carry out the latter treatment, the best battery to employ is the one here figured (Fig. 168), and the small rheophore of the author will be found convenient for conveying the primary current. It is readily passed in the same manner as a Eustachian catheter, the small piece of sponge at its end having been first dipped in a solution of common salt. The current may be completed by an elastic band holding a brass disc similar to that used for faradizing the larynx, or with a second ordinary laryngeal electrode. The brass disc can be placed over the mastoid or on the neck, or the knob of the electrode can be carried against the soft palate, over the mastoid, or beneath the ear. Contact is made and broken by the levers, or the clip devised by me (Fig. 169) can be adjusted, and thus can be used both for the faradic and galvanic currents. We roughly judge of the strength of the current by its effect on our own and the patient's lip. The

strength should never be more than what is easily borne, and no shock should be felt. With the second electrode we can complete the current in any part of the external auditory canal. We may here say that this is the only form of electricity we use for the specific objects of influencing paretic states of the tubal or intrinsic muscles, and that we have any confidence—or, indeed, much experience—in the utility of.

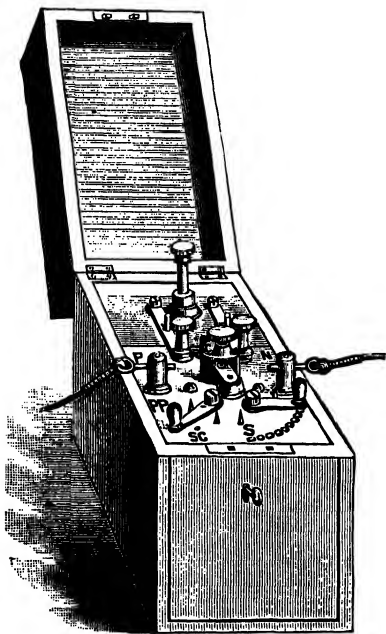


FIG. 168.—FARADIC BATTERY.

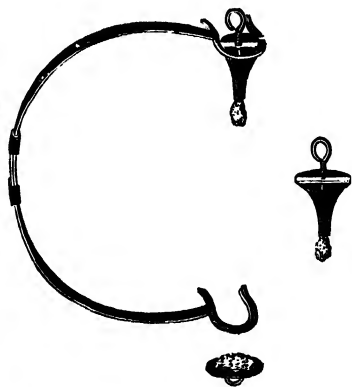


FIG. 169.—AUTHOR'S CLIP FOR MASTOID ELECTRODE AND GALVANIC SPECULUM.

We believe in it as an occasional means of correcting such conditions, and, with other remedies at our command, of alleviating thus indirectly the tinnitus.

Of the medicines, we have found of most value in vertigo and Ménière's symptoms, in addition to those already enumerated, combinations of phosphide of zinc with sulphate of zinc and chloride of barium, arsenic with quinine, strychnine, either alone or in combination, arsenious acid with valerianate of zinc with nux vomica. In cases in which we

suspect a syphilitic source of the trouble, a course at Aix-la-Chapelle, supported afterwards by periodical exhibition of the iodides, is the best treatment.

We do not propose to do more than to refer generally to the subject of electricity in affections of the internal ear. We have already spoken of faradization of the tubal and intra-tympanic muscles with a view to influencing the tinnitus present in functional affections of both. With regard to galvanism, as has been found by such authorities as Politzer, Gruber, and Schwartze, we have found but little direct benefit from the employment of the galvanic current. Though the conclusions of Brenner and Erb with regard to the effects of excitation of the auditory nerve in the diagnosis of subjective

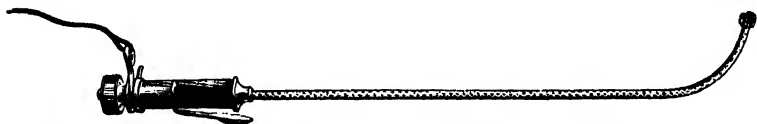


FIG. 170.—EUSTACHIAN ELECTRODE OF AUTHOR, CONSISTING OF FINE SOFT CATHETER CONTAINING WIRE TIPPED WITH SPONGE.

The battery-wire is fixed by the brass screw-handle, and contact is made or broken at will by the little lever. The indiarubber band used to carry round the neck in galvanizing the vocal cords, with a piece of sponge in the centre which is connected with the battery, is placed round the head, bringing the sponge over the mastoid process, hooking the band either round the head and over the mastoid or underneath the chin.

aural phenomena appear at first to promise important results in treatment, we cannot say that practically they have been fulfilled.

In the last edition of this work the methods of Brenner and Erb for exciting the auditory nerve, together with Brenner's formula and the auditory reactions in disease, were fully entered into (J. Cagny). The reactions in health, as compared with the anomalies in abnormal and diseased conditions of the auditory nerve, were made the basis of diagnosis; and alterations in the responses, as noted by their formula, were included under the heading of galvanic hyperæsthesia, galvanic reaction without hyperæsthesia, and torpor in the auditory nerve. Great variation in the nature of the response of the nerve to galvanic currents is common. If, on the application of the current to an affected ear, the normal sensations are completely lost and only morbid ones remain, then *conversion of the formula* was said to occur, as in the instance of old otitis media with ossicular changes and sclerosis accompanying disturbance of equilibration in the labyrinth.

Galvanism has been used for paralysis of the tympanic muscles. Should there be a lesion of the facial nerve, the stapedius suffers. This may occur in the aqueductus Fallopii, or it may be of central origin, or, again, the paralysis may follow injury or caries of the petrous bone. It follows as an occasional result of rheumatic facial paralysis, and is associated with tinnitus. For these cases careful galvanization in the manner already described may benefit, or the galvanic and faradic currents may be used alternately. The latter is likely to be the most useful. In facial paralysis, especially of a rheumatic character, where deafness or tinnitus accompanies or persists after paralysis of the facial, the best treatment is that usually employed for the primary lesion. Two electrodes of convenient size are connected with the poles of a galvanic battery. They may be of sponge or of metal, or carbon covered with wash-leather, and should be thoroughly soaked with water holding common salt in solution. These are pressed firmly into the auriculo-mastoid fossæ, and a current of 3 to 8 milliampères is passed for from one to three minutes. At the same sitting, or on alternate sittings, labile galvanization of the entire facial area is practised. A medium anode is applied behind the ear, and the nerve twigs and facial muscles are individually submitted to the cathode (small electrode), which is passed along their course; 5 to 6 milliampères current strength will suffice, and the application should not exceed five minutes.

Such electrical treatment is of undoubted utility. The intimate connection between the nuclei of the fifth and seventh nerves may explain this, inasmuch as it is difficult or impossible to stimulate the nucleus of the facial directly. In the case of the tensor tympani, we have already spoken of parietic states of this muscle which accompany similar conditions of the tubal muscles present in stenosis and occlusion of the tube. Such paresis also is associated with facial paralysis from disease of the facial and trigeminus in bulbar paralysis and diphtheria. In the case of the galvanic current, the internal electrode should be connected with the negative pole. Should excessive salivation attend upon the

galvanization of the Eustachian tube, a small sponge or pad of lint must be pressed against the orifice of the parotid duct.

The following shows the normal formula, first with a weak and then with a strong current, while the conversion of the latter in a case of chronic otitis media with partial deafness is seen [it does not follow that this reaction can always be obtained, as the patient cannot stand the discomfort]:

Normal Formula.

KC.S'	...	...	...	...	...	Loud sound.
KO	...	...	...	...	...	Nil.
AC	...	...	...	...	...	Nil.
AO	...	...	...	...	...	Weak sound.

ERB.

Strong Current.

10 cells	...	KC. Wh'	...	Loud, shrill whistling.
		KD. Wh	...	Prolonged whistling.
		KO'. h	...	Short humming.
		AC'. H'	...	Loud buzzing and humming.
		AD. H >	...	Same, fading.
		AO. Wh >	...	Whistling as in KC.

Conversion Formula.

KC.S'	...	...	Loud sound.
KD.S'	...	...	Sound diminishing and disappearing.
KO	...	...	Nil.
AC	...	...	Nil.
AD	...	...	Nil.
AO.s	...	...	Short weak sound.

ERB.

In case of otitis media.

In applying the galvanic test, the indifferent electrode—a plate of large size—is placed over the back of the neck, and the circuit is completed by pressing a sponge electrode of medium size over the external ear so as completely to occlude the external meatus. Both electrodes should be thoroughly soaked in water or a solution of common salt.

To secure anodic closure and an anodic duration, without the subsequent influence of anodic opening, the use of a rheostat is indispensable. The electrodes already described are used. The indifferent electrode may be held in the hand instead of being placed upon the neck, and that over the ear is connected throughout with the positive pole of the battery. The current is allowed to flow, being at first very weak, and gradually more cells are added. The patient is questioned as to his sensations, and no further increase of current is made when the subjective noise has ceased or become muffled to the utmost. At this point the current is

allowed to flow for about thirty seconds. Resistances are then slowly interposed by means of the rheostat until there is no reflection on the galvanometer. Repeated anodic closures are then made, each followed by anodic duration as before, and the current always removed by means of the rheostat. The current strength should always be determined in this way by its effect, and the sitting should not last more than three minutes. It may be repeated daily or on alternate days, and may have to be continued for many weeks before a complete cure is reached.

Objective Noises.—These are noises which can be heard distinctly through the auscultation-tube, and are often of a creaking or crackling character. They are sometimes associated with chronic otitis media, and have been, as in the instance of Johannes Müller and others, voluntarily produced through contraction of the tensor tympani muscle. Politzer and Luschka first attributed the voluntary production of such snapping noises to separation of the walls of the Eustachian tube through spasm of the palatal muscles. Any audible noises we have heard have been associated with movements of these muscles. Indeed, by certain gymnastic movements of the tongue against the hard palate during the first part of the first act of deglutition, snapping noises can be produced. We had a case in which spasmodic movements of the velum palati caused these noises, each movement being attended by a distinct crackling noise in the ear. The patient, a young girl, who was at the time somewhat anæmic and subject to menstrual irregularity, was completely cured by the application of the faradic current to the palate, and the administration of bromides with strychnine and iron. We had previously removed her tonsils for tonsillar hypertrophy, and there was a follicular condition of the pharyngeal wall. The state corresponded with that described by Burnett, who considered that such spasms were produced by catarrhal irritations of the palatal or pharyngeal muscles in their effort to get rid of the irritant, the sounds being caused by the vibrations in the muscular structure, and conveyed by the Eustachian tube to the middle and external ear. Urban Pritchard and others have noticed similar spasmodic movements.

CHAPTER XII

DEAF MUTISM AND TESTS FOR MALINGERING

By H. MACNAUGHTON-JONES

It is of vital importance that all who are consulted in cases of children whose hearing is either in great part or entirely lost, and the power of speech absent, should be in a position to advise parents as to the best course to pursue in the training of the child ; and it is also of vast moment, from a social aspect, that deaf mutes should be so taught as that they may become fairly useful members of society, and be fitted to fill certain positions and earn a livelihood.

Causation.—Deaf mutism is more frequently found in the poorer classes. This may in part be a consequence of neglect of those aural or collateral conditions which are apt to cause deafness in the very young, when mutism follows, and there is no more important fact to remember in connection with this defect than this : that deaf mutism is in some 50 per cent. of the cases acquired, and that the direct cause is total deafness consequent upon disease either in the middle ear or the labyrinth. Unquestionably, deaf mutism, if not immediately the result of heredity, has, in the collateral affections which are transmitted from parents, important causes determining its occurrence. Thus, we find in children of the same family naso-pharyngeal affections, goitre, and a proneness to cerebral affections. In consanguinity we find another strong influence, especially if at both sides those marrying have deaf mutism in the family. With an exceptionally large experience of typhus fever in cases of all ages, we never knew a case of deaf mutism arise directly from this

disease, though we have known several cases of permanent partial deafness of one or both ears. Complete deafness was exceptionally rare. Hartmann and Mygind, however, regard epidemic diseases and typhus fever as potent causes. Very rapid pregnancies are said by the latter authority to predispose to deaf mutism. The ear and throat should be critically examined for any local cause of deafness, and adenoid growths and hypertrophied tonsils removed if present. Should enlarged turbinals block the nares, turbinectomy should be performed.

The Management of the Deaf Mute.

We may divide the training of the deaf mute under two heads: (1) moral; (2) scholastic.

If the child live at a distance from a training-school, he should be sent to one where he would be treated by teachers of established reputation with kindness and forbearance. This *moral* training of deaf mutes is of special importance. While considerable kindness should be shown them, they ought to be made to know the difference between right and wrong; their habits of order and discipline should be carefully attended to. Foolish indulgence is as bad as excess of severity. Attention should be paid to the general deportment and carriage of the child, so as to prevent the awkwardness in gait and manner so often accompanying deaf mutism. So are the special senses of sight and touch to be cultivated. Companionship is indispensable; it enlivens the spirits, prevents moroseness, helps the cultivation of ideas, brings the child into constant contact with those who hear. Any words uttered before a child has become deaf must be taken note of, and the faculty of speech encouraged in every possible manner. We believe that, for a time at least, every deaf mute is better away from home influences and under the care of skilled teachers. It may be said that in no occupation in life is greater exercise of patience, of gentleness combined with firmness, the happy combination of a pleasant and hopeful manner without any relaxation of discipline, more demanded than in the teacher of the deaf mute.

Scholastic Training.—As it happens that a large proportion of mutes do hear sounds—the voice, certain notes, etc.—it is evident that an endeavour should be made at all times in children to increase this power. Much may be done at home in this way to train the child.

In every instance, especially when the child is sufficiently intelligent, the parents and friends should be cautioned to persevere in coaxing the child to articulate and copy sounds. The hereditary and congenital aspects of mutism are not to be forgotten, and the intermarrying of near relatives of deaf or mute persons should be discountenanced. But decidedly in all cases where such a step can be taken the child should be early removed to an institution where the teachers are accustomed to take real trouble, and to give the mute the benefit of a skilled training.

Examination of the Deaf Mute.

In all cases of deaf mutism we should exhaust every means of ascertaining the presence of any hearing-power in both the ears, trying the large and small tuning-forks, Galton's whistle, musical tones, various noises, etc. Especially with the tuning-fork should the power of perception of the upper and lower tone limits be estimated, and the respective power of the two ears in this respect. With regard to the pathological changes in the labyrinth found in deaf mutes, both exudative and hyperplastic effusions, fatty and connective tissue degeneration, atrophy of the membranous labyrinth, ossaceous degeneration with destruction both of the membranous and ossaceous canals, with general obliteration of these, have been found (Hartmann, Mygind, Moos, Toynbee, Swartze, Politzer). It would appear that males are more frequently affected than females. As might be expected from the labyrinthine changes, disturbances of equilibration are not uncommon, these being more marked in some of the more hopeless cases. Various congenital malformations have been noticed, such as absence of the labyrinth, imperfect development of the semicircular canals, and atrophic conditions of the auditory nerves, with and without congenital defects in the outer and middle ear (Lemcke, Bochdalek). That children

who are mutes may be taught to speak if the aural conditions present be attended to, and improved or cured by local treatment, is a most important fact bearing upon early treatment. Of this we have known some striking instances. Cases have been reported (Hartmann, Schmaldz, Alt) of acquired mutism consequent upon scarlet fever or other cause of suppurative otitis in which speech has been restored. Perhaps no more urgent condition demands attention in very young children than adenoid growths, which must prove, through their effects on the middle ear, a frequent source of pathological changes in very early life in the middle ear. Alt's case is a remarkable one, as the boy was seven years old, and had lost his speech for a period of four years after scarlatina. He 'became very talkative and attended an ordinary school.' Hartmann says that, 'as a rule, it may be assumed that deafness occurring up to seven years of age will have dumbness as its consequence, while speech is retained if the child be older than that. Still, there are cases on record in which children of fourteen and even fifteen years of age have lost their speech by becoming deaf. In such cases it must, however, always remain doubtful whether deafness alone was the cause of the deaf mutism.'

'We will assume,' said Tröltsch, 'that among the 38,489 deaf mutes in Germany, only 15,000 were not born with the defect, but acquired it subsequently, and we will surely not be far out if we assert that a fifth of those, viz., 3,000, if they had received timely and energetic treatment, would not have become deaf mutes, but at the worst hard of hearing to a high degree, so that they might have made use of ordinary private tuition, or could even have attended the public schools, and would, at any rate, have retained intelligible speech.'

MALINGERING.

To Detect Malingering in Cases of Feigned Deafness.

1. Examine carefully the ear and naso-pharynx for objective evidences of any aural affection.

2. *In Unilateral Deafness.*—The eyes being blindfolded, test with the watch and acoumeter the hearing distance of both ears repeatedly, the person's head being turned in different directions.

3. Place a tuning-fork (Chimani) on the middle of the vertex of the head ; ask the person which ear he hears loudest in—the malingerer will, as a rule, affirm that he hears the sound loudest in the healthy ear, or that he can detect little difference, or that he does not hear it at all in the deaf ear ; close now the healthy ear, and the malingerer will assert that he does not hear the sound, or only indistinctly.

4. Take a binaural stethoscope (David Coggin), plug one of the soft tubes, so that the sound is prevented from passing through this tube ; place now both the ear-pieces in the person's ear, taking care that the plugged tube communicates with the *hearing ear* ; speak to the person through the cup end of the stethoscope—the malingerer will say he hears ; next remove the tube from the hearing ear, and again speak through the stethoscope—the malingerer now says that he does not hear, as the tube has been removed from the sound ear.

5. *In Bilateral Deafness—*

(1) Inquire carefully into the history of the case, mode of onset, and duration of deafness.

(2) Examine both ears carefully, and apply in different methods the various hearing tests.

(3) Find if a loud noise or call will awake the person from sleep (Politzer).

(4) Propose certain operative procedures in the deaf person's presence—such as electricity, puncturing the drum with the cautery ; speak of the painful nature of these steps, watch the expression of the countenance.

(5) Try in every way to take the suspected person unawares.

CHAPTER XIII

ANÆSTHETICS IN OPERATIONS ON THE NOSE AND EAR

BY DUDLEY W. BUXTON

Choice of Anæsthetic.

THE *general condition of the patient* must, of course, largely influence the selection. Special manuals on anæsthesia deal with this, and should be consulted.

Nasal Surgery.—For *brief operations*—*e.g.*, cauterizing or removing a turbinate—nitrous oxide and oxygen answer well. When the operation is likely to occupy more than forty or fifty seconds—*e.g.*, double turbinotomy, removal of a spur—nitrous oxide followed by ether may be employed, although the choice from the surgical point of view usually falls upon chloroform, which may be given in succession to nitrous oxide and ether or the A.C.E. mixture. Chloroform should not be given when the operation requires the patient to be in the sitting posture. The previous cocainization of the nasal passages (Rosenberg) is a useful method.

Removal of Tonsils and Post-Nasal Adenoid Growths.
—Nitrous oxide alone or with oxygen does not give sufficient time for these operations, unless the case is extremely simple and the surgeon is content to hurry through his procedures in half a minute. When this anæsthetic is adopted a dental gag, or that of Doyen, should be inserted before the gas is given.

When the patient is sitting up nitrous oxide followed by ether will, if properly administered, give ample time for removal of both tonsils and adenoid growths. Care must be

taken that blood is not sucked into the larynx. If the operation is likely to be unusually long the patient should be placed supine, and chloroform or the A.C.E. mixture used. These anæsthetics cause less congestion of the tissues, and so are preferred by many. It must, however, not be lost sight of, that chloroform has proved fatal in many cases while these trifling operations have been in progress. The risk is lessened when the patient is anæsthetized with nitrous oxide and ether, and chloroform is only given immediately before and during the operation. The objection to ether is that in a percentage of cases, especially if care is not taken to avoid cyanosis during the narcotization, a troublesome amount of tenacious mucus is secreted, which obstructs the view and may cause slight respiratory difficulty.

Prolonged operations upon the nose or nasopharynx, which have to be done by sight, require chloroform, which had better be given *ab initio*.

Major operations upon the air-passages—*c.g.*, removal of goitres, hemi- or complete thyrotomy, laryngotomy, tracheotomy—are best done with chloroform. In certain cases, when it seems hazardous to employ chloroform, ether by the rectum answers well. This method has, however, its own especial dangers, and some authorities regard it as inadmissible.

For **Operations upon the Internal Ear** and for **Mastoid Disease**, chloroform, either *ab initio* or in succession to nitrous oxide and ether, is the most convenient anæsthetic. It gives rise to little engorgement if properly administered, and so renders the field of operation more easily seen. I have in some cases of even prolonged operations, such as those of Stacke, Zaufal, and Schwartze, or the grafting methods introduced by Mr. Ballance, given ether and oxygen with absolute success. No engorgement or undue hæmorrhage—a great point, when grafting is being done—occurred. These cases were of such a nature that it was feared any depression due to the anæsthetic might jeopardize the patient's life or hinder recuperative processes.

Method of Administration.

Nasal Surgery—Brief Operations.—The operations of turbinotomy, removal of post-nasal adenoid growths, and

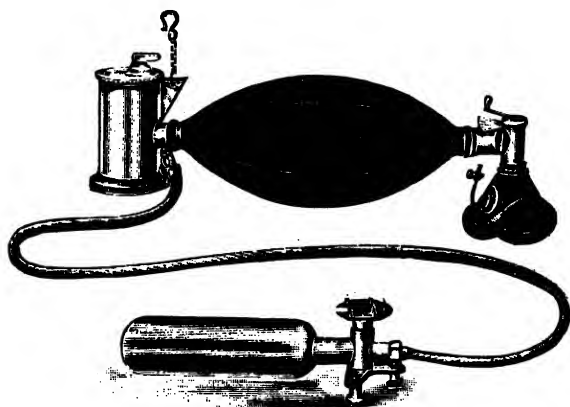


FIG. 171.—APPARATUS FOR GAS AND ETHER IN SUCCESSION

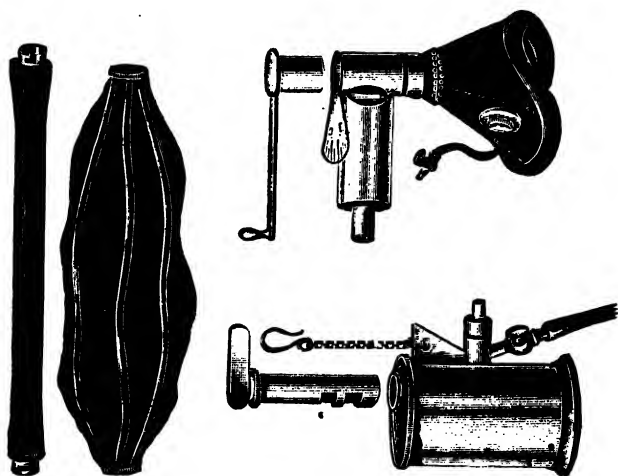


FIG. 172.—GAS AND ETHER APPARATUS, SHOWING COMPONENT PARTS SEPARATED FOR STERILIZING BEFORE USE (AUTHOR'S).

tonsillotomy may be performed under: (i.) nitrous oxide gas; (ii.) nitrous oxide gas followed by ether; (iii.) this combination followed by chloroform; (iv.) A.C.E. mixture;

(v.) chloroform, throughout the whole period of anæsthesia.

When it is decided to give nitrous oxide gas, it is well, when possible, to combine it with oxygen.

The patient may be seated in a chair, or placed on a suitable table, such as Greig Smith's, which can be raised

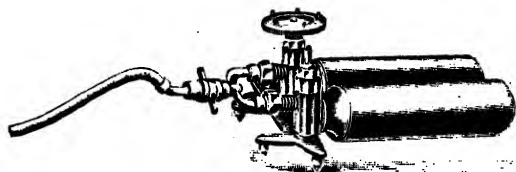


FIG. 173.—GAS CYLINDERS FOR USE WITH THE GAS AND ETHER APPARATUS.

to a level with the operator's hand; the table should be rigid and not running on casters. The anæsthetist stands behind or to the left of the patient. A gag—Doyen's is probably the best if the incisor teeth are strong—is placed in position, and the face-piece is applied. It is necessary to place a pad of cotton-wool round the handle of the gag, otherwise air enters between the mask and the face, and it is

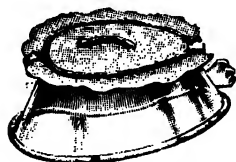


FIG. 174.—FACE-PIECE OF CHLOROFORM APPARATUS.

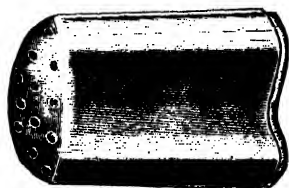


FIG. 175.—CELLULOID MASK CONTAINING SPONGE FOR GIVING A.C.E. MIXTURE.

essential that no air leaks in when gas and oxygen are being administered. If a suitable gag is not at hand, a common dental prop, guarded by a long string attachment fixed outside the mouth, can be carefully fixed between the teeth. This, if necessary, can be replaced by a handled gag at the instant the mask is removed. It is always best to have the mouth securely gagged both during turbinotomy and the removal of adenoids. We have several times seen the de-

tached turbinal fall backwards into the naso-pharynx, and had the mouth not been open and accessible the bone might readily have become aspirated into the air-passages.

The patient now inhales, and when soft snoring has continued for some seconds, and when complete narcosis has been established, the operation is performed. The anæsthetist steadies the head, and closely watches to see that blood, etc., does not enter the trachea. As soon as the operator has removed his hands, the patient's head is bent forwards and downwards to promote forward passage of the blood.

If gas is used without oxygen, it will be well for the anæsthetist to admit two respirations of air just when stertor is commencing. A brief period of apnœa will then ensue, which must not be mistaken for pathological interference with respiration. The patient then breathes gas again for five or six respirations, and as stertor again commences the mask is removed and the operation carried out.

When the **nitrous oxide** and **ether** sequence is used, the former anæsthetic is pushed only as far as the point where the patient's respiration has settled into the regular rhythm of unconscious breathing, a stage readily recognised by careful observation. Ether is then allowed to mix with the gas until all laryngeal reflex has disappeared and some cyanosis has developed. The gas-supply is then disconnected and the inhaler removed for one or two respirations, to be again replaced and kept applied until full ether narcosis is secured. If the operation promise to be a long one, it is well to 'charge up' the patient by pushing the ether until profound narcosis appears. Such profound narcosis must, however, never be permitted unless precautions are adopted to prevent blood entering the trachea, as, if the glottis has its sensibility much impaired, the protective cough of light anæsthesia will be lost. In this condition the blood is very liable to trickle into the trachea without exciting observation.

It is, therefore, usually advisable to aim at a light anæsthesia, and if the operation is not completed within its limits, either to reapply the face-piece and give more ether, or pro-

- long the anæsthesia by blowing in chloroform vapour through a mouth-tube attached to a Junker's inhaler.

When it is desirable to use **chloroform**, that anæsthetic can be administered from the apparatus (Fig. 176), or it can be given in succession to gas and ether. If the latter plan is to be pursued, the patient is anæsthetized as described above, and when he is fully under the influence of ether the face-piece is removed. A few acts of respiration will clear off all cyanosis, and then the glass face-piece of the chloroform apparatus can be applied, and chloroform given until the gentle sighing respirations characteristic of that anæsthetic become apparent.

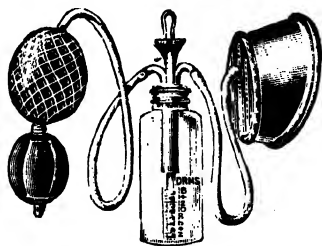


FIG. 176. --CHLOROFORM APPARATUS.

If **A.C.E.** is used, the celluloid cone (Fig 175) will be convenient. The face should be vaselined, and 2 drachms of the mixture dropped into the sponge from time to time as it evaporates.

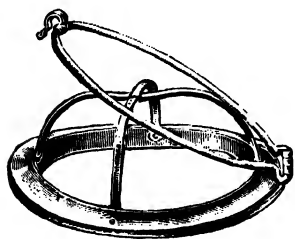


FIG. 177. --SCHIMMELBUSCH'S CHLOROFORM MASK.

Schimmelbusch's mask (Fig. 177) is used when in prolonged operations it is desirable to deepen the anæsthesia beyond the degree given by the mouth-tube. It is also sometimes useful when ether sets up cough and straining in the second degree of

narcosis. •The ether being withheld, a few respirations of chloroform are given from the mask. The face usually recovers a bright pink colour, the cough and breath holding disappears, and the ether can again be used.

CHAPTER XIV

FORMULÆ

By H. MACNAUGHTON-JONES

THE following additional formulæ are inserted here for more easy reference. Further indications as to their use, with the special indications for each, will be found in the various chapters of the book.

EXTERNAL EAR.

Used occasionally to soften Cerumen in the Meatus previous to syringing.

Bicarbonate of soda, grs. xx.

Glycerine, ℥iv.

Water to ℥i.

Liquor potassæ, ℥i.

Glycerine, ℥x.

To apply to a Dry Meatus, with absence of Cerumen.

White vaseline	} equal parts.
Lanolin	
Benzoated lard	
Glycerine	

Add 1 part of the red oxide of mercury or white precipitate ointment to 10 of this ointment.

In Eczema of the Auricle.

OINTMENTS.

Lanolated ointment of oxide of zinc, with or without salicylic acid.

Lanolin, 2 parts.

Rose water, 1 part.

Benzoated lard, 1 part,

Almond oil, 1 part.

Oxide of zinc, 1 part to 7.

Salicylic acid, 1 part to 10.

Lanolated ointment of diacetate of lead.

„ „ of oleate of lead.

„ „ of oleate of zinc.

„ „ of oxide of mercury with oxide of zinc,
equal parts.

Ichthyol (10 or 20 per cent. solution) may be added to any of these ointments.

These are made in the same proportions as the ointment of oxide of zinc.

Ointment of oxide of mercury.

Ointment of nitrate of mercury, 1 part.

Ointment of red oxide of mercury, 1 part.

Ointment of spermaceti, 10 parts.

Almond oil, 1 part.

Ointment of Caulmoogra oil.

Caulmoogra oil, 2 parts.

Lanolated zinc ointment, 6 parts.

Carbolized ointment.

Carbolic oil ($\frac{1}{20}$), 1 part.

Lanolated ointment of zinc, or

Caulmoogra oil ointment, 7 parts.

Ointment of iodoform.

Iodoform, 1 part.

Glycerine, 2 parts.

Almond oil, 2 parts.

White vaseline, 10 parts.

With vaniline, grs. v.; coumarine, grs. v.; or fresh coffee, 1 part, added as deodorizers.

Traumatol (cresyllic iodide), eucrophene, or iodol may be substituted for the iodoform in the above, in which case the deodorants must be omitted.

Ointment of lead and calomel.

Calomel	} āā grs. x.
Acetate of lead	
Lanoline, 3i.	

The stimulant or astringent ointments mentioned above may be applied to the meatus with a brush.

Aristol may be used either in powder (5 per cent.), or diluted with vaseline or lanoline.

LOTIONS.

Lime water with diacetate of lead.

Solution of diacetate of lead, $\bar{5}i$.

Lime water, $\bar{3}viii$.

Calamine lotion (Wilson).

Oxide of zinc, $\bar{5}ii$.

Calamine, $\bar{5}iv$.

Glycerine, $\bar{5}ii$.

Rose water, $\bar{3}viii$.

Some of this is used to the raw or moist surface in the daytime, lightly sponged off at night, and the lanolated, simple zinc, or other ointments applied.

Sulpho-carbolate of zinc lotion (grs. iv . ad $\bar{3}i$).

Liq. carbonis detergens ($\bar{5}ss$.– $\bar{5}i$. ad $\bar{3}vi$).

Acetate of lead (gr. i . ad $\bar{3}i$).

Carbolic acid, 1 in 500 to $1,000$.

Boric acid (grs. x . ad $\bar{3}i$).

Calomel (lotio nigra, B. P.).

APPLICATIONS.

Nitrate of silver. Apply a pencil lightly after removal of the scab and drying the surface.

Nitrate of silver solution, various strengths, to be applied with a brush.

Chromic acid solution (grs. x .–grs. xx . ad $\bar{3}i$).

Carbolic acid with glycerine (m. xxx . ad $\bar{3}i$), to be applied with a cotton-wool holder.

Chloride of zinc solution (grs. xx .–grs. xxx . ad $\bar{3}i$).

Iodoform or iodol. To be applied either in powder or in a solution of eucalyptol or ether.

Ointment of iodide of starch.

Iodide of starch, 1 part.

Oxychloride of bismuth, 1 part.

Powdered starch, 6 parts.

To dust a foul surface.

Traumatol, iodoform, and iodide of starch are indicated in syphilitic cases.

In Chronic Eczematous Conditions of the External Meatus.

APPLICATIONS.

Saturated solution of boric acid, 2 parts.

Absolute alcohol, 1 part.

Glycerine, 1 part.

To be applied with the aural probe or cotton-wool holder, or with a stiff camel's-hair brush, after cleansing and drying the meatus.

Salicylic acid may be used in the same manner.

Carbolic acid, 1 part.

Absolute alcohol, 1 part.

Glycerine, 4 to 10 parts.

Chromic acid solution (grs. x.—grs. xx. ad ʒi.).

Iodoform or iodol solution (ʒi. ad ʒi.).

Ichthyol solution (10 per cent.), dissolved in alcohol and water.

In Purulent Discharges from the Ear.

LOTIONS.

Sulpho-carbolate of zinc (grs. iv. ad ʒi.).

Sulphate of zinc (grs. iv. ad ʒi.).

Boric acid (grs. x. ad ʒi.).

Salicylic acid (grs. ii. ad ʒi.).

Chloride of zinc (grs. v. ad ʒi.).

Chinosol (1 in 1,000).

Liquid traumatol, 1 in 3 of water.

Carbolic acid, 1 in 500 to 1,000.

Potassium permanganate (grs. ii. ad ʒviii.).

Acid perchloride of mercury solution (1 in 5,000), acidulated with tartaric acid (grs. iii. ad ʒi.).

Formalin (formic aldehyde), 1 in 10,000.

Double iodide of mercury and potassium, 1 in 2,000.

Hydronephthol, 1 in 3,000.

Hydrogen peroxide, 2 per cent. (10 to 20 per cent., to arrest hæmorrhage).

Lead and opium (acetate of lead, gr. i.; tinct. opii., ℥ xv. ad ʒi.).

Sulphurous acid, 1 in 10.

Witch hazel (distilled extract), Hazeline.

Lotions are best ordered in the concentrated form, to be added to a given quantity of *recently boiled water*, and used thus diluted; for example: Boric acid, ʒii.; biborate of soda, ʒiv.; absolute alcohol, ʒi.; glycerine, ʒi.; distilled water, ʒii. ʒii.-ʒiv. to be added to the ʒiv. of warm water.

Sulpho-carbolate of zinc, ʒii.; chloride of zinc, ʒi.; carbolic acid, ʒi.; absolute alcohol, ʒii.; distilled water, ʒii.

To be used in the same manner as the last.

To relieve Pain in the Ear in Otitis Externa, Myringitis, or Neuralgia.

INSTILLATIONS.

Eucaïne B. solution.

Cocaine solution, 10 per cent.

Hydrobromic ether with glycerine, 1 in 7.

Adrenalin or renaglandin; also to arrest hæmorrhage.

APPLICATIONS.

Chloroform, 9 parts.

Liniment of aconite, 1 part.

Applied to mastoid.

Laudanum, 1 part.

Liniment of belladonna, 1 part.

Applied to mastoid.

VARIOUS.

Leeches (2 to 4). Applied to front of tragus.

Fomentation of decoction of poppy-heads and camomile flowers.

The same of laudanum water.

Post-aural vesication or counter-irritation.

Leiter's temperature-tube and Sprague's ice-bag.

Ointment of veratrin, applied over mastoid.

Hypodermic injection of morphia.

In Aspergillus.

APPLICATIONS.

After disinfection of the meatus, applications of boric acid in solution with absolute alcohol.

Absolute alcohol and glycerine.
 Solution of hypochlorite of lime (grs. ii ad ʒi.).
 Hydronaphthol, 1 in 2,000.
 Chinosol, 1 in 300 to 600.

INSUFFLATION.

Chinoline salicylate, 1 part.
 Boric acid, 15 parts. (Bennett.)

Exostosis in the Meatus.

Application with aural probe of chromic acid (grs. xxx. ad ʒi.).
 Nitrate of silver (grs. xx. ad ʒi.).
 Chloride of zinc. (grs. xxx. ad ʒi.).
 Tincture of iodine.

MIDDLE EAR.

Suppurative Otitis Media.

LOTIONS (*see also Purulent Discharges*).

Warm anodyne and weak and antiseptic lotions :
 Laudanum and decoction of poppy-heads.
 Bicarbonate of soda (grs. v. ad ʒi.).
 Chloride of ammonium (grs. v. ad ʒi.).
 Boric acid (grs. iv. ad ʒi.).
 Bichloride of mercury, 1 in 5,000.
 Permanganate of potash (grs. ii. ad ʒviii.).
 Sulpho-carbolate of zinc (grs. ii. ad ʒi.).
 Salicylic acid (grs. ii. ad ʒi.).
 Chinosol (1 in 1,000).
 Hydrogen peroxide (2 per cent.).
 Formalin (1 in 10,000).

To be used separately or in combination.

POWDERS FOR INSUFFLATION.

Boric acid.
 Salicylic acid, 1 part ; boric acid, 3 parts.
 Resorcin, 1 part ; boric acid, 8 parts.
 Iodol.
 Iodoform.

APPLICATIONS TO GRANULATIONS, ETC.

Chromic acid (ʒi. ad ʒi.).

Chloro-acetic acid (trichloracetic).

Carbolic acid.

Nitrate of silver (grs. xxx. ad ʒi.).

Absolute alcohol, 1 part; carbolic acid, 1 part; glycerine,
1 part.

To be applied with absorbent wool on the cotton-wool holder.

Intratympanic Medication in Catarrhal Conditions.

VAPOURS.

Iodine.

Guaiacol.

Chloride of ammonium.

Guaiacum.

Iodoform.



FIG. 178.—UNIVERSAL NEBULIZER OF OPPENHEIMER.*

SOME SOLUTIONS TO BE USED WITH THE EUSTACHIAN OR TYMPANIC CATHETER.

Bicarbonate of soda (grs. v. ad ʒi.).

Chloride of ammonium (grs. ii.—grs. v. ad ʒi.).

Iodide of potassium (grs. ii.—grs. iv. ad ʒi.).

Chloride of sodium (grs. v. ad ʒi.).

Paroleine.

Pilocarpine (1 to 2 per cent.).

EMBROCATIONS AND COUNTER-IRRITANTS.

To be applied over the Mastoid Process.

Chloroform, 2 parts.

Spirit of horseradish, 1 part.

Tincture of capsicum, 1 part.

Tincture of aconite, 1 part.

* This nebulizer may be attached to the Eustachian catheter.

Oil of mustard, 1 part.
 Spirit of horseradish, 1 part.
 Liniment of chloroform, 2 parts.
 Belladonna liniment, 1 part.
 Aconite liniment, 1 part.
 Camphor liniment, 2 parts.
 Chloroform, 1 part.
 Iodine, 1 part.
 Mastich, 1 part.
 Rectified spirit, 8 parts.

An iodide pigment, to apply to the mastoid process ; it may be mixed with equal parts of flexile collodion.

Liquor epispasticus (Smith's), to apply to the mastoid with a brush.

Charta epispastica. A small portion cut to shape and applied to the mastoid.

INTERNAL EAR.

Tinnitus Aurium.

INTERNAL REMEDIES.

FOR RELIEF OF VASCULAR TENSION.

Hydrobromic acid, dil.
 Caffeine (citrate or hydrobromate).
 Bromides of potassium, ammonium, and strontium.
 Bromide of zinc.
 Bromide of caffeine.
 Hydrobromate of cocaine.
 Hydrobromic ether, ℥v.
 Powder of acacia, grs. xx.
 Glycerine, ℥xx.
 Water, 3ss. (Turnbull).
 Nitrite of amyl (in capsule or palatinoid).
 Nitro-glycerine (in tablet).
 Ergotin.
 Hydrastin hydrochloride ($\frac{1}{2}$ gr. palatinoids).
 Sclerotic acid.
 Tinct. of arnica.

Muriate of pilocarpine, 2 drops of a 2 per cent. solution injected subcutaneously, and repeated at intervals, care being taken to promote the action of the skin and prevent any subsequent chill.

TONICS.

Bromide of gold.	Quinine hydrobromate.
Bromide of iron.	Strychnine.
Phosphide of zinc.	Arsenic.

VASCULAR TONICS.

Digitalis.	Strophanthus.	Convallaria.
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Syphilitic Affections of the Internal Ear.

Mercurial (lanoline) inunction.

Bicyanide or bichloride of mercury (gr. $\frac{1}{2}$).

Tannate of mercury (grs. i.—grs. ii.).

Pilocarpine hypodermically.

Iodide of potassium or the mixture of the three iodides—potassium, sodium, and ammonium. Iodide of strontium. Iodoform.

Aix-la-Chapelle, course at.

Tinnitus in Anæmic Cases.

Iron salts (various).

Pyrophosphate of iron (syrup of).

Fellows' and Easton's syrups.

Robin's compound glycono-phosphates.

Iodide of iron.

A pill of—

Arsenious acid, gr. $\frac{1}{6}$.

Quinine, gr. i.

Sulphate of iron (dry), gr. i.

One after food three times in the day.

Blaud's pills or bipalatinoids.

Hæmoglobin.

Bromide of iron with bromide of gold.

NASO-PHARYNX.

NASAL AND POST-NASAL INSUFFLATIONS (*alone or combined*).

Oxychloride of bismuth, gr. ss.—gr. i.

Starch (maize), grs. ii.—grs. iii.

Iodol, gr. ss.

Starch (maize), grs. ii.—grs. iii.

Iodoform, gr. ss.

Starch (maize), grs. ii.—grs. iii.

Europhene, grs. ii.—grs. iii.

Starch (maize) grs. ii.—grs. iii.

Tannic acid, gr. ss.—gr. i.

Starch (maize), grs. ii.—grs. iii.

Alum (dry), gr. ss.—gr. i.

Starch (maize), grs. ii.—grs. iii.

Bismuth, grs. ii.

Morphia, gr. $\frac{1}{12}$.

Starch, grs. iii.

Menthol snuff, 1 part in 7.

Hydrochlorate of morphia, grs. ii.

Acacia powder, $\bar{5}$ ii.

Subnitrate of bismuth, $\bar{3}$ i.

} Ferrier's snuff.

Hydrochlorate of cocaine, grs. x.

Hydrochlorate of morphia, gr. i.

Camphor powder, grs. xx.

Subnitrate of bismuth, $\bar{5}$ i.

} Moore's Snuff.

Camphor.

Tannic acid.

White sugar.

High-dried Welsh snuff (equal parts).

} Dobell's snuff.

PHARYNGEAL INSUFFLATIONS.

Iodol, gr. $\frac{1}{4}$ —gr. ss.

Iodoform, gr. $\frac{1}{4}$ —gr. ss.

Tannic acid, gr. ss.

Oxychloride of bismuth, gr. ss.

Trisnitrate of bismuth. gr. ss.

Catechu, gr. ss.

Kino, gr. ss.

Alum, gr. ss.

} Diluted with starch, lycopo-
dium, or both.

NOSE AND NASO-PHARYNX.

NASAL SPRAYS (*for use with aqueous atomizer*).

In making up the following aqueous solutions it is necessary to add 10 per cent. of glycerine, in order to bring them to a suitable specific gravity for use with the vaporizer; when employing an ordinary atomizer they may be used plain.

Adrenalin.

Alum (grs. ii.—grs. v. ad ʒi.).

Biborate of soda (grs. x. ad ʒi.).

Bicarbonate of soda (grs. x.—grs. xx. ad ʒi.).

Boric acid (grs. v. ad ʒi.).

Carbolic acid (grs. iii. ad ʒi.).

Chloride of ammonium (grs. x. ad ʒi.).

Chloride of sodium (grs. xx.—grs. xxx. ad ʒi.).

Chloride of zinc (grs. ii.—grs. v. ad ʒi.).

Chlorinated soda, liq. sod. chlor. (ʒi. in ʒiv.).

Cocaine (4 to 10 per cent.).

Ferro-alumini (gr. i.—grs. ii. ad ʒi.).

Iodoform in ether (grs. xx. ad ʒi.).

Permanganate of potash (gr. i. ad ʒi.).

Quinine (grs. vi. ad ʒi.).

Salicylic acid (grs. ii. ad ʒi.).

Sulpho-carbolate of zinc (grs. ii. ad ʒi.).

Sulphurous acid (2 per cent.).

Tannic acid (grs. iii.—grs. v. ad ʒi.).

Thymol (1 in 2,000).

Volatile oils used in the treatment of nasal disorders are readily nebulized, and may be dissolved in any of the fatty paraffin oils which do not turn rancid by keeping.

Pinol, 1 in 9.

Thymol, 1 in 9.

Eucalyptol, 1 in 9.

Menthol, 1 in 7 to 14.

Iodoform, 1 in 60.

Carbolic acid, 1 in 19.

Camphor, 1 in 4.

AN ALKALINE AND ANTISEPTIC NASAL LOTION.

Sod. bicarb. } $\bar{a}\bar{a}$ grs. x.
 Sod. bibor. }
 Sodii salicyl., grs. ii.
 Boracic acid, grs. ii.
 Carbohc acid, grs. ii.
 Water, $\bar{3}$ i.

The following formula contained in soluble 'aseptoids' we have found most useful—

Cocaine mur., $\frac{1}{6}$ gr.
 Borax, $2\frac{1}{2}$ grs.
 Menthol, $\frac{1}{50}$ gr.
 Sodium chloride, 7 grs.
 Boracic acid, $\frac{3}{4}$ gr.
 Sodium benzoate, $\frac{1}{2}$ gr.
 Thymol, $\frac{1}{100}$ gr.
 Ol. gaultheriæ, min. $\frac{1}{20}$.

In catarrhal states of the nose and pharynx or larynx—two dissolved in an ounce of water as a spray or gargle (Oppenheimer).†

STRONGER TOPICAL REMEDIES FOR THE NARES AND NASO-PHARYNX.

Chromic acid (grs. x.—grs. xx. ad $\bar{3}$ i.).
 Tannic acid (grs. x.—grs. xx. ad $\bar{3}$ i.), with glycerine.
 Nitrate of silver (grs. x.—grs. xxx. ad $\bar{3}$ i.).
 Chloride of zinc (grs. xx.—grs. xl. ad $\bar{3}$ i.), with glycerine.
 Iodoform, in ether (grs. xx.—grs. xxx. ad $\bar{3}$ i.).
 Sulphate of copper (grs. xxx. ad $\bar{3}$ i.).
 Compound tincture of benzoin and glycerine, equal parts.
 Carbohc acid with glycerine, various strengths.
 Perchloride of iron (grs. xxx.— $\bar{5}$ i. ad $\bar{3}$ i.).
 Boric acid, saturated solution.
 Aldehyde and glycerine, equal parts.
 Glacial acetic acid.
 Lactic acid, 40 per cent. to pure.

See Figs. 140, 143, 144, 151, 153, pp. 257, 260, 266, 267, for nasal douches, irrigators, nebulizers, etc.

† The same formula was originally given by us for the 'naso-pharyngeal' tablets of Messrs. Burroughs and Wellcome.

MEDICATED NASAL CYLINDERS.

These are small hollow glyco-gelatine cylinders, which are inserted into the nasal passages in hollow vulcanite plugs. They are variously medicated with different quantities of such drugs as bismuth, cocaine, iodoform, lead, menthol, etc. The process of liquefaction takes several hours, during the whole of which time the surface is exposed to the action of the drug, and is kept moist by the glyco-gelatine. Neither cylinder nor plug can slip back into the pharynx, as each plug is supplied anteriorly with a small thread, by means of which the two are tied together. The respiration is unimpeded. The cylinders should only be used while in the horizontal position.

STEAM SPRAYS (*to use with Steam Atomizers in water at a temperature of 140° to 150°*).

Thymol, 1 in 2,000.

*Terpinol (min. xv. ad ̄x.).

*Eucalyptol (min. xv. ad ̄x.).

*Ol. pin. sylvestris (min. xv.—min. xx. ad ̄x.).

Tincture of iodine (min. xx. ad ̄x.).

Compound tincture of benzoin (min. xxx. ad ̄x.).

Camphorated spirit (min. xxx. ad ̄x.).

‘Concentrated camphor water’ mixes well with water, and may be used as a basis for other inhalants (̄ii. ad ̄x.).

Carbolic acid (min. xv.—min. xx. ad ̄x.).

*Creosote (min. x. ad ̄x.).

Light carbonate of magnesia may be added to suspend the oils in water thus :

Ol. eucalypti	} āā ̄i.
Ol. pin. syl. (vel. terpinol)	
Magnes. carb. lev., ̄i.	
Aq. camph. concentr., ̄i.	
Aquam, ad ̄iv.	

̄ss. added to the ½ pint of water at 150° for steam atomizing or inhalation in Spencer Thompson’s naso-oral jug inhaler (see text).

* Those marked * can be had in *palatiroids*, each containing 5 minims, which are most convenient for calculating the quantity to be used ; they are dropped into the hot water, and quickly liberate the contents which medicate the vapour.

APPENDIX

THE value of the Galton whistle in estimating the perceptive power of the ear for high tones is well known to every otologist, and it is more especially useful when used side by side with the tuning-fork for the differentiation of simple middle-ear deafness and that arising from some affection of the labyrinth or auditory nerve. To obtain a whistle which would give us certain records of the varying hearing for these higher tones was a matter of the greatest importance for the otologist engaged in estimating the improvement in hearing made by the patient. This could only be done by an accurate and carefully-taken record of the hearing-power when the patient first came, and retesting from time to time at subsequent visits.

Fig. 179 shows the most recently-constructed 'Galton-Pfeife,' by means of which, and by the aid of Kundt's dust figures, the relative number of vibrations in such high tones is accurately determined, as well as the number of vibrations per second in each.

Up to quite recently the testing of the tones of the Galton whistle was confined to experiments made with each instrument tried by the hearing of an ear in which the sense was supposed to be perfect. The length of the pipe was reduced to the smallest point of audible vibration, its mouth also being made as small as practicable. This gave the limit of hearing of the ear at the time it was tested. Below this nothing was heard save the passing of the air through the pipe, the surmise as to the highest tones that the particular whistle was capable of producing being arrived at by a calculation derived from a knowledge of the lowest tone that particular whistle could produce, the length and calibre of the pipe being known. The influence of the distance of the mouthpiece from the pipe in producing the tone was not taken into consideration, and hence the conclusions arrived at as to the higher tones were only approximately correct. It has been clearly proved by Kundt's dust figures that the production of these upper tones varies according to the position of the mouthpiece from the pipe. Thus, in the new Galton pipe of Edelmann regular vibrations are only produced when the mouthpiece is distant from the pipe between 1·8 and 3·8 millimetres, any further widening of the space preventing production of clear tone. It records a tone of 54,900 complete vibrations at a length of pipe of 0·2 millimetres and

0.6 width of mouth.* Pure tones can only be measured if the length of the pipe is not reduced below 8 millimetres. Melde holds that the perception of high notes depends to some extent on the strength

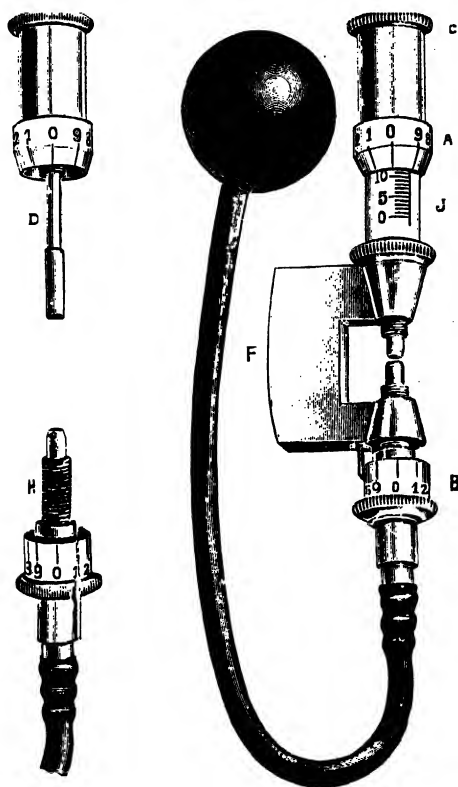


FIG. 179.—GALTON-PFEIFE (HALF NATURAL SIZE), No. 446.

C A J, barrel with lid and scale, regulating the length of the pipe D in millimetres, from 0 to 25 millimetres. E, section of pipe with its piston, showing the circular space surrounding the piston. G, section of mouthpiece, showing the circular space through which the air is driven through the rubber band by the pipe D. B, scale, showing in ten equal divisions the degree of rotation of the mouthpiece, thus regulating its distance from the aperture of the pipe. F, handle to hold the Galton-Pfeife by. H, screw of mouthpiece.

of the tone, and those of the new pipe are very strong. With it we can prove absolutely that some persons can hear tones of 50,000, or even

* By taking the exact length of a wave with a compass and millimetre measure, and dividing the velocity of sound (at mean temperature) by this, we arrive at the number of vibrations in a given tone— ..

more, vibrations. 'When we formerly supposed,' says Edelman, 'that we had reached the highest audible tones, we were most likely mistaken, as in all probability the pipe did not sound.'

It will be seen from Fig. 179 that the 'Galton-Pfeife' consists mainly of two parts, with an intermediate strong handle (F) to hold the whistle steadily by. The upper portion is the pipe (D), which is fitted accurately with a piston. This can be readily moved up or down in the pipe by the lid (C), which stops its cylindrical opening (E). The distance of the piston from the lower end of the pipe is marked by a scale (J), most perfectly adjusted in millimetres, from 0 to 25. The lower part is the mouthpiece, which has an aperture in the form of a ring (G), through which the air passes, and this being brought directly opposite the aperture in the lower end of the pipe, the column of air between the two vibrates. An indiarubber ball is attached to the tube of the mouthpiece, and this being held in the hollow of the hand, by compressing the ball with the tip of the thumb air is propelled through the pipe, when the tones, varying in height according to the distance of the mouthpiece from the pipe and the position of the piston on the latter, are produced. The drum (B) attached to the mouthpiece has its circumference divided into ten equal parts. By rotation of the drum the length of the mouthpiece is altered, and thus its distance from the body of the pipe can be varied, and the 'mouth width' can be defined in tenth parts of a turning of a screw. We thus see that we can immediately vary and accurately measure in millimetres the length of the column of air in the pipe, and at the same time regulate the exact distance of the mouthpiece from it. Necessarily, the lower the piston in the pipe and the nearer the mouthpiece, the higher the note and the greater the number of vibrations.

Schwendt has made use of Kundt's dust figures to estimate the number of vibrations for each high tone as it is produced by the Galton pipe. These dust figures are produced in the following manner: A perfectly clean and dry glass tube is closed at one end with a cork, and some dry lycopodium is poured into the pipe while it is held vertically, and it thus collects at the bottom or closed end of the tube. By now

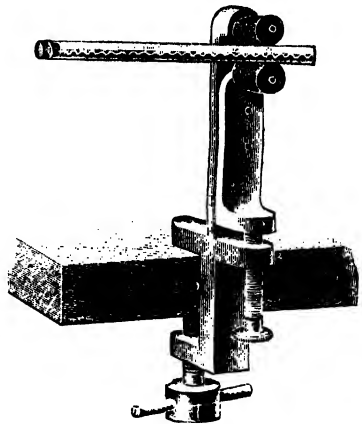


FIG. 180.—EDELMAUN'S VICE AND CLAMP FOR HOLDING THE DUST TUBE.

holding the tube in a slightly slanting direction, with the open end downwards, and by tapping it first at right angles and finally in the direction of the axis of the tube with a slender stick of wood, such as a pencil, the powder is readily distributed in a long and narrow layer along the tube (Fig. 1, Plate VI.). This requires a little practice. The tube is now held in a horizontal position, and turned slightly, so that the stream of powder lies a little on one side. The mouth of the pipe is next placed exactly opposite the aperture of the tube, and when the pipe is sounded the column of air in the tube vibrates. Where the vibrations of air are the more powerful the powder falls to the greater distance, but is stationary where the nodes are present. Festoons are thus produced, and these ventral segments form an undulating line. Two of the former constitute a wave (Fig. 2, Plate VI.). The number of these waves can then be measured. Anyone can carry out this experiment for himself. The festoons, with their ciliated projections, are beautifully seen against the dark ground of a sheet of black cloth or copying paper.

For measuring the higher tones shorter and narrower tubes should be used. A stick of sealing-wax, some 5 or 6 inches long, is taken, and the middle of the tube is fixed on this. The lycopodium stream is then distributed, and the lower end of the wax is fixed to a piece of wood or the side of the table. The tone is then taken (Fig. 3, Plate VI.). Each time the experiment is repeated it is better to remove the tube from the table for redistribution of the powder. Following these simple directions of Schwendt, I have had no trouble in obtaining, in tubes of various sizes, the characteristic dust waves. The greatest care must be taken to thoroughly dry the tube, by a sand-bath or otherwise. Both ends should then be corked and dipped in paraffin. The tube should be first cleaned with nitric acid and alcohol. Dried mustard-seeds are also useful for the purpose. I have photographed some of these. Fig. 2, Plate VI., shows a wave taken with the pipe 22.4 millimetres in length, and the mouth width 2.2 millimetres, representing the tone A^4 , 3,480.00 vibrations per second. Fig. 3, Plate VI. shows five waves (ten ventral segments) 11 centimetres, that is, 110 millimetres, each wave being 22 millimetres in length. These waves were produced by a length of pipe of 10.75 millimetres, and a mouth width of 1.4 millimetres, producing the tone E^6 , 6,960.00 vibrations per second. Fig. 4, Plate VI., shows eight waves (sixteen ventral segments), measuring $12\frac{1}{4}$ centimetres—that is, $122\frac{1}{2}$ millimetres—each wave being about 15 millimetres in length. These waves were produced by a length of pipe 5.35 millimetres, and 0.89 of a mouth width, representing a tone of G^6 , 12,401 vibrations per second. Fig. 5, Plate VI., shows fourteen

waves (twenty-eight ventral segments), measuring 75 millimetres, each wave being 5·3 millimetres. These waves were produced by a length of pipe 1·01 millimetres, and a mouth-width of 0·89. Fig. 6, Plate VI., shows waves produced by a length of pipe 0·5 millimetres, and 0·89 of mouth width. The ten waves measure over 44 millimetres, each wave being 4·4 millimetres, representing a tone of 10^8 , or 37,162·24 vibrations per second.*

I take but a few clinical examples for my purpose. A lady consulted me for deafness of considerable duration, which had been for some time stationary. Physical signs, and the various usual tests with watch, tuning-fork, and by whispering, proved the case to be one originally of middle-car deafness, associated with stenosis of the Eustachian tubes. Watch not heard on contact. Tuning-fork C (260 vibrations) and C (512 vibrations) were heard by bone-conduction well and badly by air-conduction (Rinne), the sound ceasing rapidly. By the 'Galton-Pfeife' I found that she heard 7,812·32 vibrations per second with the right ear, and 6,960·00 with the left. Testing her repeatedly, the same result was arrived at. There was no doubt that here there was also cochlear involvement.

A lady who had suffered in the past from otitis media, resulting at the time in perforation in one ear, which had been for some time closed, responded but imperfectly to the tests of acoumeter, watch, and whispering, hearing the tuning-fork about equally to bone and air conduction. There was no Eustachian obstruction or collapse in the right ear, but there was stenosis of the left tube. Her principal symptoms were those associated with rigidity of the membrane and ossicular ankylosis, difficulty of hearing in general conversation, and the necessity for fixing her attention in listening. With her right ear she heard 32,870 vibrations well. In the left ear she heard about 30,000. The labyrinth here was obviously intact.

A gentleman who had been deaf for some years, hearing only loud speech, not hearing the watch on contact with either ear, and the acoumeter only by bone-conduction with the right ear, and at 2 inches by conduction with the left, gave a marked negative response to Rinne's test. There were clear clinical signs of middle-car affection. He did not hear the C fork (260 vibrations) by air-conduction with either ear,* but heard the fork (512 vibrations) held at the same distance with both ears. Tested with a 'Galton-Pfeife,' he heard 13,640 vibrations per second with the right ear, and with the left somewhat less. There was here some impairment of the labyrinth as well as the middle-ear affection.

* In the table, Fig. 1, Plate VI., the correct lengths of these waves are given, in accordance with the reduction in the actual size of the tubes.

Galton-Pfeife No. 116.

Tönerbezeichnung	Pfeifenlänge	Mundweite	Schwingungszahl pro Sekunde	Schwingungszahl pro Sekunde	Pfeifenlänge	Mundweite	Schwingungszahl pro Sekunde	Pfeifenlänge	Mundweite
a ¹	12.9	2.2	3900,00	10000	7.2	1.1	40000	0.11	0.19
a ²	14.0	-	3600,16	11000	6.56	-	41000	0.1	-
a ³	15.05	-	4136,46	12000	5.61	0.19	43000	0.11	-
a ⁴	15.15	-	4046,26	13000	5.2	-	43000	0.14	-
a ⁵	16.2	-	5213,68	14000	4.95	-	44000	0.1	-
a ⁶	17.1	1.1	5524,16	15000	4.66	-	45000	0.15	-
a ⁷	17.1	-	6200,64	16000	4.58	-	46000	0.12	-
a ⁸	18.55	-	6980,00	17000	4.19	-	47000	0.15	-
a ⁹	20.12	-	7812,32	18000	3.90	-	48000	0.12	-
a ¹⁰	21	-	8272,96	19000	3.61	-	49000	0.14	-
a ¹¹	22	-	8280,56	20000	3.4	-	50000	0.12	-
a ¹²	23.1	-	10627,46	21000	3.2	-	51000	-	-
a ¹³	24.1	-	11046,32	22000	3.03	-	52000	-	-
a ¹⁴	25.55	0.10	12401,26	23000	2.86	-	53000	-	-
a ¹⁵	25	-	13430,00	24000	2.63	-	54000	-	-
a ¹⁶	26.4	-	15024,64	25000	2.61	-	55000	-	-
a ¹⁷	27.5	-	16565,92	26000	2.5	-	56000	-	-
a ¹⁸	28.1	-	18561,12	27000	2.39	-	57000	-	-
a ¹⁹	28.1	-	20054,72	28000	2.29	-	58000	-	-
a ²⁰	29.01	-	22096,64	29000	2.2	-	59000	-	-
a ²¹	29.1	-	24862,56	30000	2.11	-	60000	-	-
a ²²	30	-	26240,00	31000	2.05	-	61000	-	-
a ²³	31.1	-	31280,26	32000	1.91	-	62000	-	-
a ²⁴	32	-	33664,96	33000	1.8	-	63000	-	-
a ²⁵	33.5	-	37192,24	34000	1.68	-	64000	-	-
a ²⁶	34.5	-	41900,64	35000	1.58	-	65000	-	-
a ²⁷	35.9	-	44183,26	36000	1.5	-	66000	-	-
a ²⁸	37.1	-	49605,12	37000	1.43	-	67000	-	-
a ²⁹	38	-	52496,00	38000	1.36	-	68000	-	-
a ³⁰	39	-	62496,56	39000	1.22	-	69000	-	-
a ³¹	40	-	68183,66	40000	1.12	-	70000	-	-

FIG. 181.—TABLE ACCOMPANYING NO. 446 'GALTON-PFEIFE.'

This table gives the tones, the lengths of pipe, widths of mouthpiece, and vibrations per second for each tone. Also the length of pipe and width of mouthpiece required to produce a given number of vibrations per second, from 10,000 to 50,000.

In a case of typical old middle-ear deafness, the accumulator heard only by bone-conduction, the watch not heard on contact, with evidence of gross middle-ear changes, and complete Eustachian obstruction in the left ear, the hearing for high tones was equal to some 35,000 vibrations per second. There was no evidence of any labyrinthine trouble. In the right ear the hearing was normal.

An officer holding an important command in South Africa was

PLATE VI.—KUNDT'S DUST-WAVES.



FIG. 5.



FIG. 6.



FIG. 4.



FIG. 3.

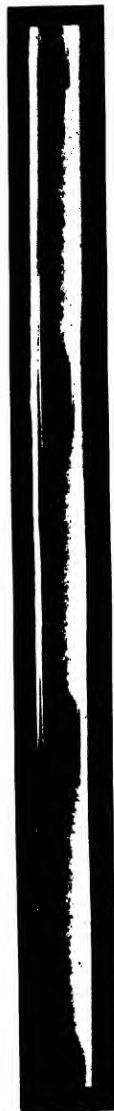


FIG. 2.



FIG. 1.

Fig. 1. Layer of Lycopodium in Tube.

Fig. 2. Tube (nat. size) dust-waves from length of pipe 22.4 mm. : mouth width 2.2 : vibration per second 3,430.00 : tone A₄.

Fig. 3. " " (reduced $\frac{1}{2}$) " " " 10.75 " " " 1.4 " " 6,900.00 " E₂.

Fig. 4. " " " " " 5.35 " " " 0.89 " " " 12,411.25 " H₂.

Fig. 5. " " " " " 1.01 " " " 0.89 " " " 31,249.23 " D₂.

Fig. 6. " " " " " 0.75 " " " 0.89 " " " 51,678.75 " D₃.

Fig. 7. " " " " " 0.50 " " " 0.89 " " " 68,898.75 " D₄.

Fig. 8. " " " " " 0.25 " " " 0.89 " " " 137,797.50 " D₅.

Fig. 9. " " " " " 0.125 " " " 0.89 " " " 275,595.00 " D₆.

Fig. 10. " " " " " 0.0625 " " " 0.89 " " " 551,190.00 " D₇.

Fig. 11. " " " " " 0.03125 " " " 0.89 " " " 1,102,380.00 " D₈.

Fig. 12. " " " " " 0.015625 " " " 0.89 " " " 2,204,760.00 " D₉.

Fig. 13. " " " " " 0.0078125 " " " 0.89 " " " 4,409,520.00 " D₁₀.

Fig. 14. " " " " " 0.00390625 " " " 0.89 " " " 8,819,040.00 " D₁₁.

Fig. 15. " " " " " 0.001953125 " " " 0.89 " " " 17,638,080.00 " D₁₂.

Fig. 16. " " " " " 0.0009765625 " " " 0.89 " " " 35,276,160.00 " D₁₃.

Fig. 17. " " " " " 0.00048828125 " " " 0.89 " " " 70,552,320.00 " D₁₄.

Fig. 18. " " " " " 0.000244140625 " " " 0.89 " " " 141,104,640.00 " D₁₅.

Fig. 19. " " " " " 0.0001220703125 " " " 0.89 " " " 282,209,280.00 " D₁₆.

Fig. 20. " " " " " 0.00006103515625 " " " 0.89 " " " 564,418,560.00 " D₁₇.

Fig. 21. " " " " " 0.000030517578125 " " " 0.89 " " " 1,128,837,120.00 " D₁₈.

Fig. 22. " " " " " 0.0000152587890625 " " " 0.89 " " " 2,257,674,240.00 " D₁₉.

Fig. 23. " " " " " 0.00000762939453125 " " " 0.89 " " " 4,515,348,480.00 " D₂₀.

Approximately the length of the respective waves in these figures is nearly Fig. 2 = 100 mm. ; Fig. 3 = 45 mm. ; Fig. 4 = 20 mm. ; Fig. 5 = 10.6 mm. ; Fig. 6 = 8.8 mm. The slight inaccuracies in the length of the waves in the figures are due to the fact that the figures were produced from photographs. Figs. 5 and 6 are engravings from photographs, as it was found difficult to get the waves directly done from the negatives. Long exposure was necessitated in consequence of the defective light.

struck in his tent by lightning, which rendered him unconscious. Besides other effects at the time, there was a red spot on the mastoid, and the hair over the ear was burnt off. A fairly large perforation resulted beneath the malleus, and another larger one in the posterior segment. Periodical tinnitus followed, and still occurs. Hearing has been fairly restored, as he now hears a whisper in the affected ear, and, as measured by the pipe, some 12,000 vibrations per second. With his good ear he hears about 35,000 vibrations per second. The auditory nerve was here probably affected by the injury.

Having examined the hearing of a number of persons with assumed normal hearing, I have found that a small proportion can reach from 45,000 to 50,000 vibrations per second, and a very large number from 37,000 to over 40,000.*

Each pipe is numbered as it is issued from the Physico-Mechanical Institute of Professor Edelman, and accompanying it is a table (Fig. 181) giving all the measurements for length of pipe and mouth width for the higher tones, and the corresponding number of vibrations per second. A second column gives the length of pipe and the mouth width for vibrations per second from 1,000 to 50,000. The table figured is that of the 'Galton-Pfeife,' No. 446, the one I have been using.

Lucae's Elastic Pressure Probe for Vibratory Massage.

Professor Lucæ has devised the instrument† shown (Fig. 182) to effect direct massage of the ossicular chain, thereby causing vigorous vibration in it, which are produced by pressure on the spiral spring contained within the handle of the instrument. Its 'buffer' is applied to the processus brevis of the malleus. He restricts the pressure to 200 grammes, its cup disc being covered with a thin layer of cotton fastened to it with collodion. A 10 per cent. aqueous solution of cocaine is frozen in a mixture of ice and salt, and the end of the pressure probe is kept in this for some minutes. In this manner an anæsthetic effect is produced; the patient's head having been properly fixed and the instrument applied to the processus brevis by a gentle to-and-fro movement of the handle of the probe, the massage is effected. Lucæ combines the use of his pressure masseur with the

* The 'Galton-Pfeife' can be obtained through the agency of Messrs. Arnold and Sons, West Smithfield.

† A full description of Professor Lucæ's instrument, the use of which he demonstrated at the Sixth Otological Congress in 1899, will be found in a paper on 'Vibratory Massage in the Treatment of Progressive Deafness, with Special Consideration of the Elastic Pressure Probe,' in the *Laryngoscope* of September, 1900 (St. Louis), being a translation by Dr. N. A. Goldstein.

pneumatic or electric massage. He expresses his preference for Delstanche's small hand masseur rather than the electric masseur of Ostmann. The use of the pressure probe must be carried out with extreme gentleness and care, as its application is ill borne by many.



FIG. 182.—LUCAE'S PRESSURE PROBE (LATEST MODEL).

patients, and is not infrequently followed by congestion of the membrana tympani, with redness or ecchymosis.

Even in the use of the pneumatic masseur, whether Delstanche's or other, care has to be taken in regard to the force and rapidity of the massage movements. This particularly applies to the earlier sittings. Nor is it well to fit the rubber ear-piece air-tight into the meatus, as otherwise unpleasant consequences, such as those we have referred to, with possibly increase rather than the diminution of the tinnitus, with the production of vertigo, may follow. Lucae says that in the first sitting no more than from two to five strokes of the pressure probe should be attempted, gradually increasing it on subsequent occasions, rarely going beyond twenty-five. We do not prolong the application of Delstanche's pneumo-masseur for more than from five to ten minutes.

PLATE III.—SOME OTOLOGICAL APPLIANCES.

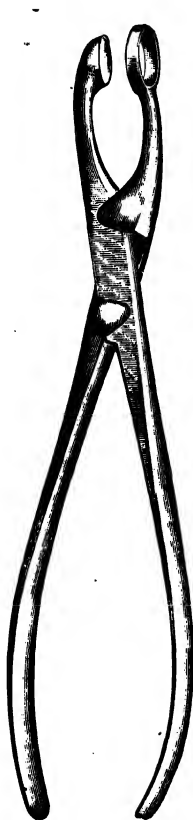


FIG. 1.



FIG. 2.



FIG. 3.



FIG. 4.

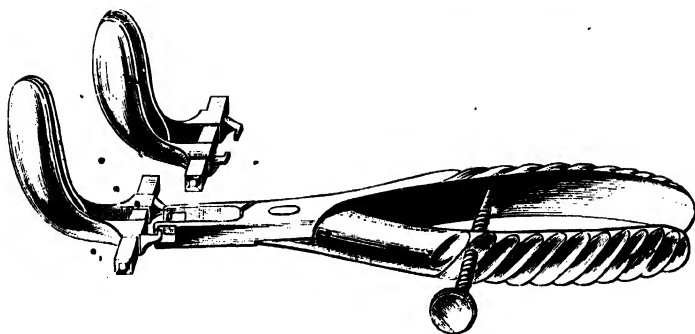


FIG. 5.

Figs. 1 and 2, Septum Punches. Fig. 3, Cutting-Forceps for Turbinals.
 Fig. 4, Carmault Jones's Spokeshave for Turbinals. Fig. 5, Delstanche's
 Septum Clamp.

PLATE IV.—SOME OTOLOGICAL APPLIANCES (*continued*).

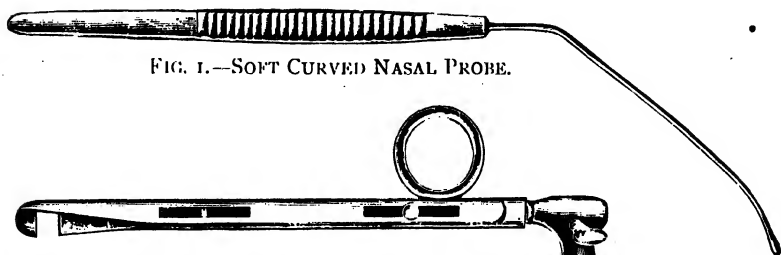


FIG. 1.—SOFT CURVED NASAL PROBE.

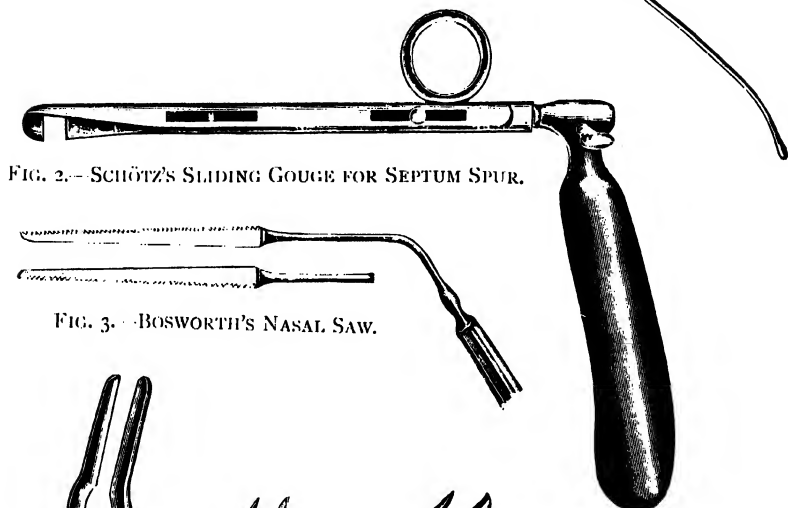


FIG. 2.—SCHÖTZ'S SLIDING GOUGE FOR SEPTUM SPUR.

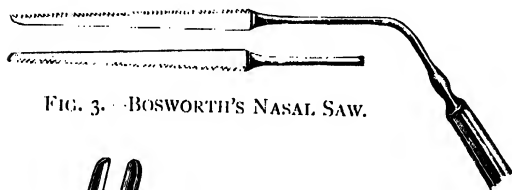


FIG. 3.—BOSWORTH'S NASAL SAW.



FIG. 4.



FIG. 5.



FIG. 6.

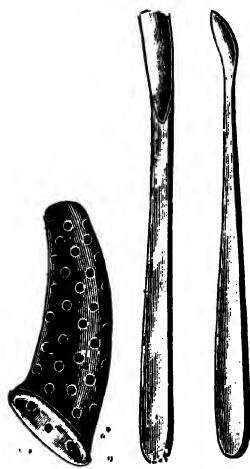


FIG. 7.

FIG. 8.

FIG. 9.

ASCHE'S INSTRUMENTS FOR DEVIATED SEPTUM. *continued*

Fig. 4, Compressing Forceps. Fig. 5, Straight Forceps. Fig. 6, Angular Forceps (right and left). Fig. 7, Hollow Nasal Splint. Fig. 8, Gouge. Fig. 9, Raspatory.

PLATE V.—SOME OTOLÓGICAL APPLIANCES (*continued*).

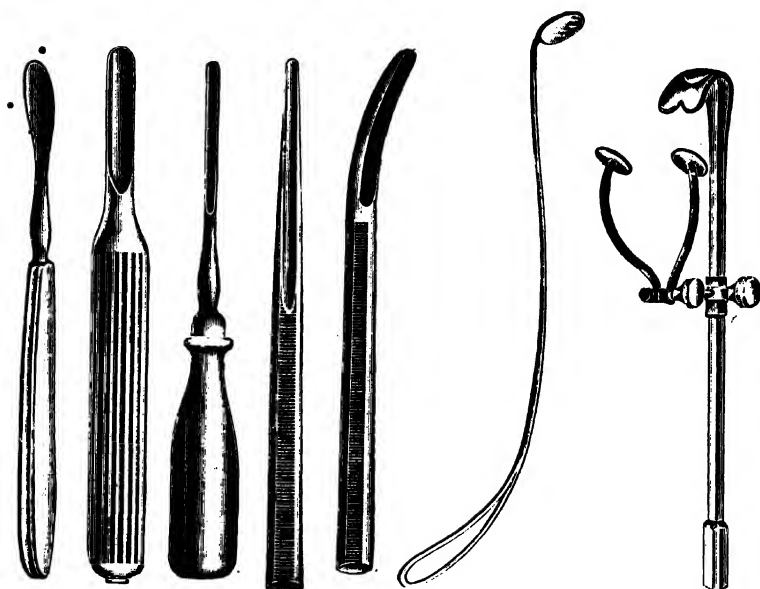


FIG. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5. FIG. 6. FIG. 7.

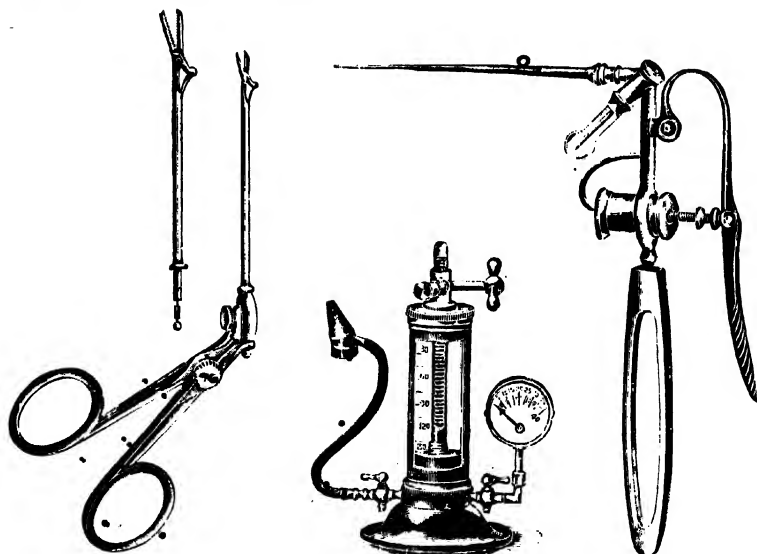


FIG. 8. FIG. 9. FIG. 10.

Figs. 1 to 5, Elevator and Grooved Chisels for the Radical Operation. Fig. 6, Meta-
 •Mirror for use in same. Fig. 7, Uvula Elevator of Schmidt. Fig. 8, Politzer's
 Incus Scissors and Forceps. Fig. 9, Cordes' Masseur with Manometer. Fig. 10,
 Delstanche's Intra-tympanic Injector and Aspirator.

PLATE VA.—SOME OTOLOGICAL APPLIANCES (*continued*).

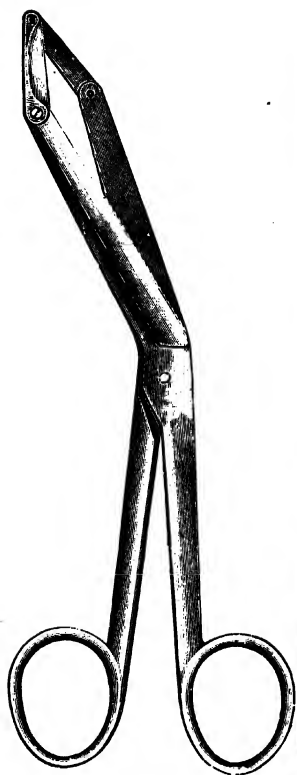


FIG. 1.

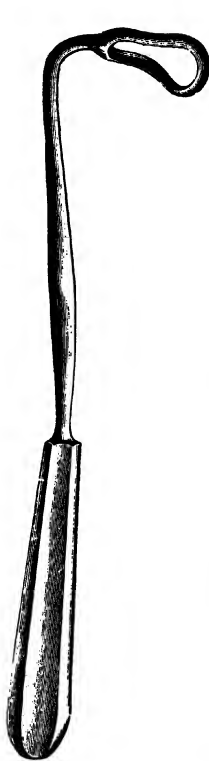


FIG. 2.



FIG. 3.



FIG. 4.

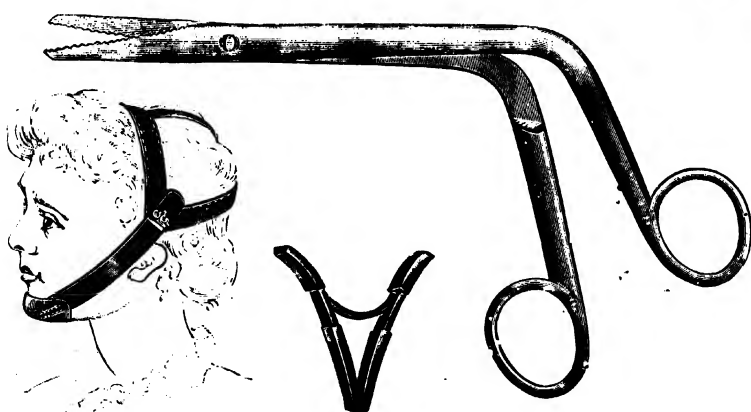


FIG. 5.

FIG. 6.

FIG. 7.

Figs. 1 and 7, Nasal Scissors (Grundwell). Figs. 2 and 3, Modified Ring-Knives (Schmidt and Beckmann). Fig. 4, Mouth-Gag of Delstanche (three sizes). Fig. 5, Chin-Band of Delstanche. Fig. 6, Catheter Nasal Clip (Delstanche).

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